Light and LIGHTING

OCTOBER, 1956 • PRICE 2s. 6d.

Light and LIGHTING

Vol. 49. No. 10. October, 1956

Published by The Illuminating Engineering Publishing Co. Ltd. on the 1st of each month at 32, Victoria Street, London, S.W.1. Telephone: ABBey 7553. - Subscription rate 30s. per annum.

contents

Concrete Lamp-posts

ADVERSE criticism of concrete street lamp-posts has been voiced in the daily Press quite frequently, and during the recent meeting of the British Association these "utilities" were again attacked. Unfortunately, those who are most vocal in their condemnation are also least constructive as to acceptable alternatives. Nor do they take account of all the factors—especially cost of maintenance—which must be weighed by those who have to act for the general public in such matters as the choice of street "furniture." Many of the traditional lamp-posts with which we have long been familiar are more deserving of condemnation than those which are now receiving it. Probably their advent excited scathing comment, too, but we have learned to live with them without violent distaste, and we must learn to live amicably with their modern successors because we need them—as we do many other modern contrivances which are easily decried by the aesthete. Strangely enough, it is often designers of modern buildings who damn concrete lamp-posts most heartily, but—Heaven knows—some modern buildings are damnably ugly !

Notes and News

THE summer recess is over and a new IES session is about to begin and a new President take office.

Dr. W. E. Harper, who will present his Presidential Address entitled "Lighting and Social History" at the Royal Institution at 6 p.m. on Tuesday, October 9, is a well-known member who has rendered many services to the Society over a number of years. In addition to membership of the Council, he has been a vice-president and served as honorary editor of the *Transactions* with conspicuous success. He has presented a number of papers at meetings in London and in the Centres, and was twice awarded the Leon Gaster Memorial Premium—in 1948, with Mr. H. P. Walker for a paper on acrylic plastics in lighting presented at the first Summer Meeting at Harrogate, and in 1955, with Mr. A. G. Palmer, for an equally outstanding paper on lighting in hazardous and corrosive situations.

W. E. Harper, IES President, 1956—57

Dr. Harper was educated at King Edward VI School, Stourbridge, and at Birmingham University, where he graduated with B.Sc. and Ph.D. in electrical engineering. From 1938 to 1946 he was in the illumination department of the Research Laboratories of the General Electric Co., Ltd. Since 1946 he has been with the Plastics Division of Imperial Chemical Industries Ltd., where he is responsible for work dealing with the application of plastic materials to lighting equipment. In this latter field his work is known internationally, and there can be little doubt that it has played a large part indeed in the extensive development of the use of plastics in the lighting industry during recent years. A Fellow of the Society and a Member of the IEE, he represents the British Plastics Federation on the National Illumination Committee and on various BSI committees.

The duties of the IES President grow each year, involving not only attendance at Council and committee meetings and sessional meetings in London and visits to the Centres, all of which take up a great deal of his time, but also, as the Society grows, demanding more and more attention to matters of detail connected with the development and future activities of the Society. This is particularly true at the present stage in the Society's affairs. Few people realise just how much time the President does give to the Society during his year of office; the new President takes over at a critical stage in the development of the Society, involving as it will the submission of a new constitution.

We wish Dr. Harper every success during his term of office and are confident that the affairs of the Society will be in very good hands.

Mr. Higgins retires from office after a most successful year, which included a really first-class Summer Meeting. The work done by a president is not, however, always apparent during his term of office. As mentioned in the last annual report the constitution of the Society has been under review for some time. During the last year (and more) Mr. Higgins has given a good deal of time to this matter which is of great importance to the future development of the Society and for years to come the Society will have cause to be grateful to him.

The Lighting Society

It has been announced that a proposal to change the name of the IES to The Lighting Society is under consideration. A letter explaining the reasons for the proposal has been sent by the IES President to Corporate Members of the Society resident in the United Kingdom asking them to express an opinion for or against the proposal on a reply-paid postcard enclosed with the letter. On the replies received the IES Council will decide whether to incorporate the proposed new title in the revised constitution which will be submitted to members in the normal way in due course.

Briefly, the reasons given for changing the name are as follows. Whereas when the Society was first formed nearly 50 years ago the term "illuminating

engineering " no doubt adequately expressed the combination of certain aspects of gas and electrical engineering then practised by the majority of members, it does not now have the same meaning nor express the interests of members. Indeed, though the term is still fairly widely used by the industry, in almost any context it could be replaced by the word "lighting," which is usually what is meant and which has the advantage that it is readily understood by the layman. Many people are interested or concerned with lighting who would not understand the meaning of illuminating engineering. The lighting designer is concerned with many more things than just illuminating or providing a certain amount of illumination; he has to cover a much broader field.

The term " illuminating engineering " in our mind is a relic of the days when all that seemed to matter was the illumination on what was called the working plane. Is there any lighting engineer who still feels that that is all his job involves ?

It is hoped that as many as possible, whether for or against the proposal, will record their opinion. We feel most strongly that with the simpler more expressive and more readily understood title the Society will be able to make much greater progress and impact on the community than it will by sticking to its present one, however much respect it may have gained over the years.

Coloured Views

An architect writing about lighting and colour is usually either provocative or stimulating and the Building Bulletin No. 9, " Colour in Schools," is no exception. This methodical approach to the design of coloured decoration to suit the structure and the lighting of school premises is well worth study by lighting engineers, as illustrated by the following quotations :

" No one has ever seen a building without colour. It follows that before a new building is occupied, and on various occasions during its life, someone has to select from the almost innumerable possibilities a very limited number of colours which appear to serve his purpose."

" If colours are to be chosen purposefully, architects, and the clients whom they advise, must in practice consider systematically the functions which colour can be made to perform and the particular effects which it is desired to achieve. The design of a colour scheme is, first, an analytical process and, secondly, a creative act of the imagination."

" In planning a school the architect will, through the disposition of the sources of light, impose a particular pattern of light and shade inside the building. In a good design this pattern will be consciously worked out and, before it is decided what colours to use, the whole interior will be imagined in terms of light and shade."

These ideas, and particularly the last, set a high standard, and we sometimes wonder how many, either artists or engineers, can really visualise the effect of the lighting they are going to create. Moreover, the deliberate creation of contrast, of directional lighting and of shaded areas calls for an integrated design which is far removed from—and in some buildings far better than—the uniform diffusion of light which seems to be the aim of some installations. To quote again :

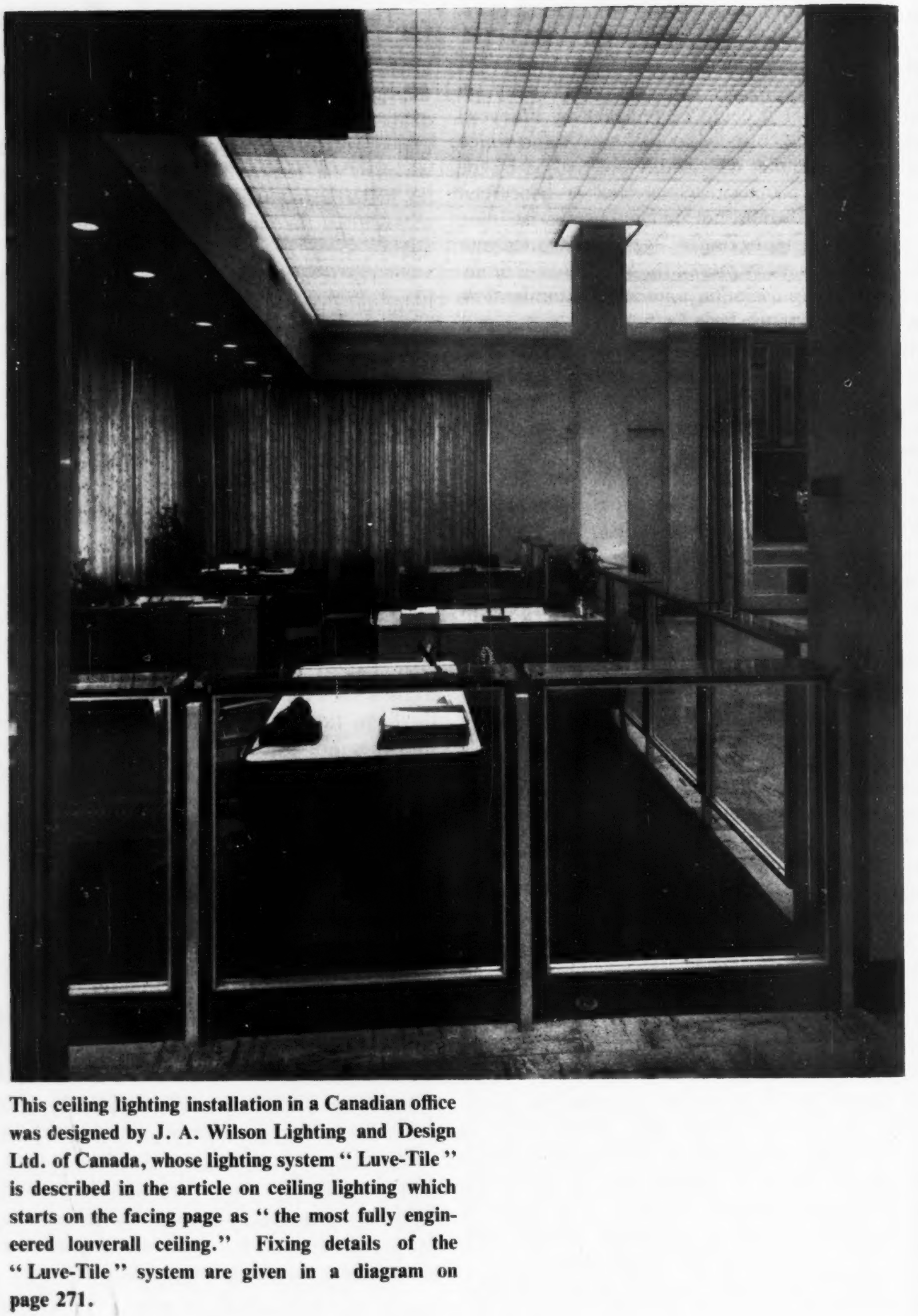
" The echoing by colour of the natural pattern of light and shade will be the more exciting where there are contrasts. An interior gains interest if light sources and levels of illumination vary."

Building Bulletin No. 9 is now in its second edition. It describes the basis of colour schemes for both new and old school premises, and similar principles could well be applied to many other types of building. It includes a new Archrome Range of colours, selected from the new BS 2660 also issued within the last few months. This series replaces the first Archrome (Munsell) Range, and it comprises 54 colours over a wide range of hue, saturation and brightness, selected and arranged so that a harmonious choice can be easily made at high or low reflection factors. The colours are reasonably proof against abnormal distortion in colour appearance in daylight, tungsten filament light or fluorescent light, and they are listed by the leading paint and colour manufacturers. Altogether this is an admirable booklet, and we recommend it particularly to those lighting engineers who may have to discuss these matters with members of the architectural profession.

IES Programme

The IES programme for 1956-57 is quite an impressive one; there are to be 11 meetings in London alone including the Fourth Trotter-Paterson Memorial Lecture which is to be given by Sir Lawrence Bragg at the Royal Institute on Monday, February 11. The programme covers a wide range of subjects of importance to both lighting and non-lighting people and shows that the Society's interests are by no means limited to " illuminated engineering " ! Indicative of the wider outlook of the society is the paper by Paul Reilly on May 14 on changing tastes in design.

We also see that London has a new meeting place, the Federation of British Industries at 21, Tothill Street (near the Abbey and St. James's Park tube station), which has a very good and comfortable lecture hall.



This ceiling lighting installation in a Canadian office was designed by J. A. Wilson Lighting and Design Ltd. of Canada, whose lighting system " Luve-Tile " is described in the article on ceiling lighting which starts on the facing page as " the most fully engineered louverall ceiling." Fixing details of the " Luve-Tile " system are given in a diagram on page 271.

Lighting in Service Ceilings

By Derek Phillips, M.Arch. (M.I.T.), M.C.D., B.Arch.(L'pool.), A.R.I.B.A.

THE scope of this article is limited to ceilings, or elements of ceilings, which are suspended—i.e., ceilings which, for their support, rely on an independent load-bearing structure. Forms of construction in which the load-bearing structure itself incorporates the lighting components are not dealt with, though it might be thought that this effects a better relationship between the lighting and the fabric of the building, as there is no implication that something is hidden.

There are many practical and aesthetic reasons for the popularity of the "false" ceiling. From the lighting engineer's point of view it is obviously an advantage to be able to regard the ceiling as a lighting element. But he must collaborate closely with the designers of various types of suspended ceiling, such as acoustic and fireproof ceilings, for it is only by the development of lighting equipment which co-ordinates fully with other services that the real advantages of the suspended ceiling system can be gained.

In the past, the roof timbers of many important buildings were left exposed, often painted and gilded, and they played an important part in the architectural expression of the building. An obvious example is the English hammer-beam roof. These buildings were designed in an age when no attempt was made to control climatic and other conditions, and any engineer who has had the task of applying modern services to such a building knows the difficulties of relating artificial lighting, heating, ventilation and other services to the structure, it being unthinkable to use a suspended ceiling.

The flat ceiling dates in England back to at least the late sixteenth century and, in principle, there is little difference between the lath-and-plaster ceiling applied to traditional timber floors and roofs and the modern suspended ceiling. Both hide the structure, and both hide whatever wiring and other services can be placed between the ceiling and the flooring or roofing boards above.

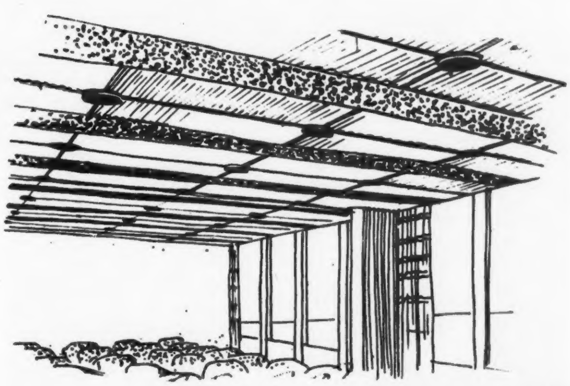
With the need to provide for additional and more complicated services, the depth between the joists or the concrete slab and the ceiling has been increased, though the structural depth of the slab may remain about the same. Moreover, it becomes necessary to have clear runs for the various pipes and ducting to be distributed—in other words, the service space must be free from obstructions. Hence, the value of the "false" ceiling—i.e., a ceiling independent of the main structure and hung from it at intervals which allow the passage of the services to be provided.

The suspended ceiling is essentially a "service" ceiling, incorporating one or more of the following: Electrical wiring, telephones and intercom; heating and/or ventilation, air conditioning; lighting equipment; acoustic control; fire protection, sprinkler system.

The need to provide space for these services is the main reason for choosing a suspended ceiling, but there are other reasons which may influence an architect's choice. Certain modern forms of building construction, such as the reinforced concrete slab with projecting beams, give only an intermittent ceiling level, and if the architect wants an uninterrupted ceiling plane, a suspended ceiling will be necessary. Several new forms of construction comprise small structural elements, e.g., open-web beams at close centres, such as the 40-in. grid used in lightweight school construction. In these buildings, the ceiling is essentially non-structural and the depth at which it is fixed may be varied to give lower ceilings at certain points on the plan, to hide service ducts, or to add a fireproof membrane. In shops and stores, emphasis of certain areas by variations in ceiling level is particularly effective.

With regard to costs, the site labour involved in placing in position carefully designed factory-made units, which are quick and easy to erect and which co-ordinate with other building components, balances to some extent the greater cost of the materials themelves, and, once in position, they can be altered with less difficulty than traditional forms of ceiling.

Architects who have chosen to use a suspended ceiling in a particular building



Lecture theatre at General Motors' technical centre, Detroit

have been quick to grasp the advantages of recessed lighting units, so that a ceiling which may have been designed for acoustic or heating reasons becomes a "total" ceiling in which all the elements of heat, light and sound are integrated. Lower ceiling heights have contributed to this tendency, as it is often undesirable to lower the height still further by using suspended fittings.

An analysis of the existing forms of suspended ceiling shows that there are three distinct types which have become fully engineered systems:—

1.—Completely luminous ceilings.

2.—Acoustic ceilings, with or without heating, with recessed lighting units.

3.—Fireproof ceilings.

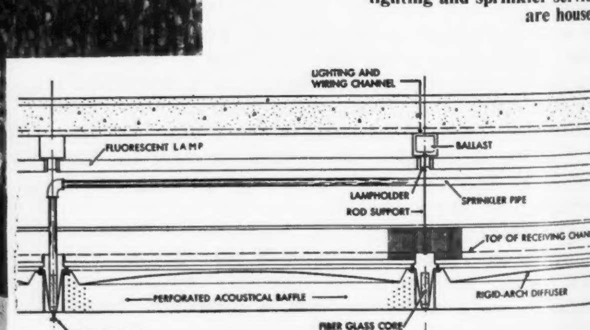
1 completely luminous ceilings

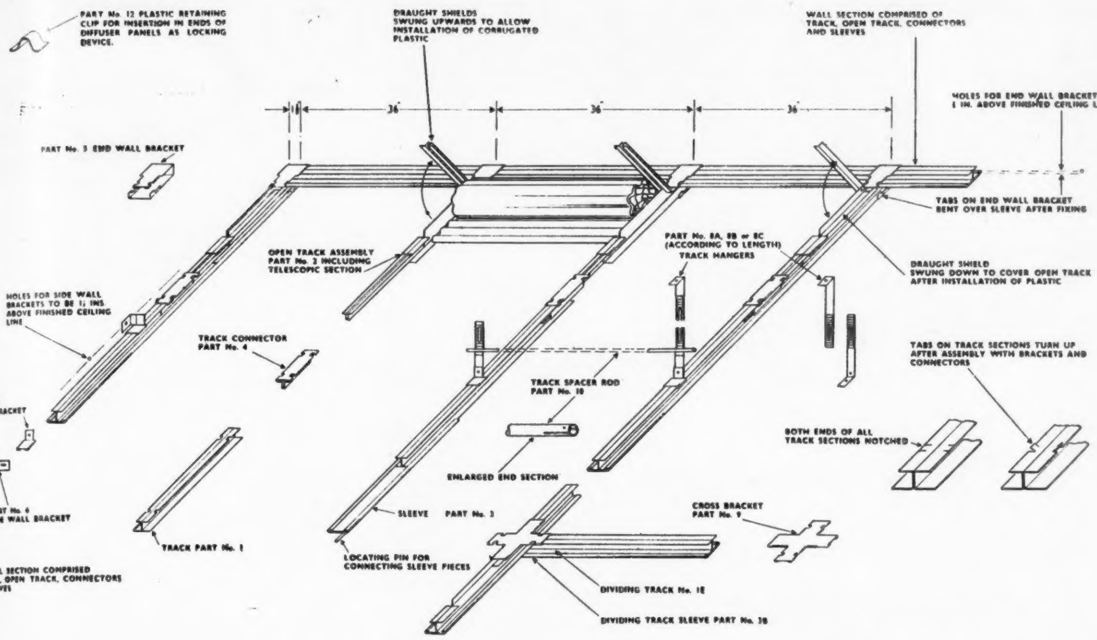
This type of ceiling has been developed primarily by the lighting engineer. Perhaps the most fully developed in the category is the Wakefield "Thetaplex" ceiling, developed in the United States by the Wakefield Company of Ohio. This is composed of rigid-arch acrylic plastic diffusing elements supported on perforated acoustic baffles. The diffusing elements are flashed by fluorescent lamps mounted on the structural ceiling. The acoustic baffles cut down the view of the lit ceiling and help to reduce glare. The joints of the acoustic baffles are arranged to accept sprinkler heads, for fire control (see Figs. 1 and 2).

Other completely luminous ceilings are the corrugated vinyl "luminous ceiling" first developed by the Martin Electric Co. in the United States, and the louverall ceiling. The luminous ceiling is gaining popularity in this country under the trade name of "Lumenated Ceiling"—a form which consists of a thin sheet of corrugated vinyl, spanning between specially designed H-sections spaced at 3 ft. centres, suspended below fluorescent or other light sources (see Figs. 3 and 4). Acoustic control can be given to this type of ceiling by the addition of absorbent material above the vinyl, the latter being said to be relatively transparent to sound except that of very high frequency. Alternatively, acoustic baffles may be added to the supporting H-sections, this having the added advantage that the baffles restrict the view of the expanse of lit plastic, which could become a glare source and may be monotonous if not used in moderation. This type of lit ceiling is being used for exhibition and display work, and in offices, shops and stores. In America it has been tried out in schools, but with current standards of lighting cost would prohibit its use in British schools.

The most fully engineered louverall ceiling is that designed by J. A. Wilson Lighting and Display Ltd. of Canada and marketed under the name of "Luve-Tile" (see Figs. 5 and 6—the photograph on page 268). Easily handled units, about 1 ft. square, fit together with a simple suspension and clip into units 3 or 4 ft. square which can be hinged to

Left, Fig. 1, office of the Hydon-Brand Electric Co., New York, with completely luminous ceiling—a Wakefield "Thetaplax" ceiling by the Wakefield Company of Ohio. Below, Fig. 2, cross section showing how the rigid-arch acrylic plastic diffusing elements are supported and how the lighting and sprinkler services are housed.





facilitate the servicing of the light sources above. This type of ceiling is particularly useful in exhibitions and shops, but its use in offices is restricted because of the reflected glare from the light sources above. The lamps themselves are cut off from normal angles of view, but specular reflection can be annoying when light sources directly above are reflected on shiny surfaces, such as glossy paper, typewriters or other office machinery.

All the systems mentioned above can be operated in conjunction with air conditioning or hot-air distribution systems, and with other services, such as power for electrically operated machines and wiring for telephones and public address systems. Sprinkler systems, too, can be added if required.

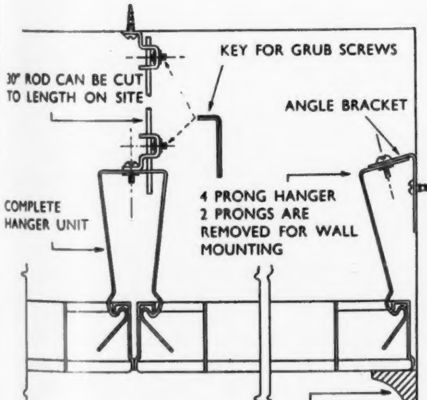
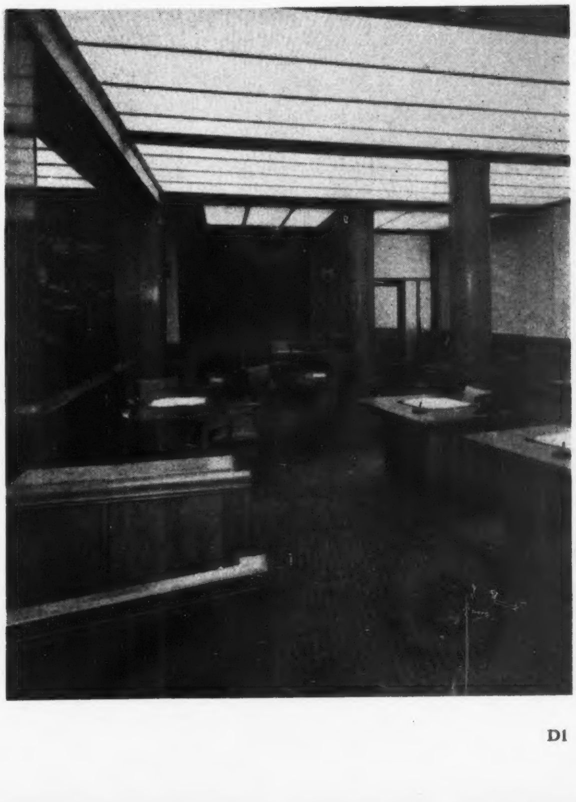


Fig. 5. Method of supporting the Canadian luminous ceiling system known as "Luve-Tile". Fig. 6—a photograph of a "Luve-Tile" installation—appears on page 268.

Above, Fig. 3, assembly diagram of the "Lumenated" ceiling (manufactured in Great Britain by Lumenated Ceilings Ltd.). Below, Fig. 4, a "Lumenated" ceiling installation in the Manchester branch office of the Co-operative Permanent Building Society.



2 acoustic ceilings, with or without heating, and recessed lighting

This type of ceiling is essentially an opaque ceiling, with recessed or surface-mounted lighting fittings. Developed at first for its acoustic properties, the ceiling may be used for any of the other reasons already outlined. The types of material used differ widely, as do the methods of suspension. Many acoustic boards have been developed, and they are supported either on simple T-sections (see Figs. 7 and 8), which are expressed as a line on the ceiling, or, in more elaborate installations, by secret fixings. One of the best known of the latter type is the "Cullum" method of suspension and channelling, which includes a special fixing plate designed to support "Acousti-Celotex" panels. There has been a tendency for the companies specialising in suspended ceilings, in conjunction with board manufacturers, to standardise on a 2 ft. by 2 ft. unit, which is easy to handle, fix and support. Consequently, manufacturers of lighting equipment have developed units which fit exactly into the spaces left when one, two or three ceiling panels are removed (see Figs. 9 and 10). These "modular" lighting units are a useful tool for the architect, but only if the lighting scheme is planned in advance, for due to the obstructions caused by the ceiling suspension units, it is not possible to remove *any* panel at will and replace it with a lighting unit.

The ceilings themselves are made to fine tolerances of both dimension and loading, and lighting equipment of any substantial weight (e.g., fluorescent equipment with its associated gear) must, therefore, be supported independently from the ceiling. This is usually done by incorporating suspension points in the structural slab. Alterations can be made to these installations after the building is completed, but such alterations must be limited to given lines planned free of ceiling suspensions and ducting.

An alternative to the board panel is the metal pan with acoustic material laid in it. This type of ceiling was first developed in conjunction with heating pipes, so that the panels could act as radiant heating elements. Several fully engineered systems are now available, the Frenger system being noteworthy, because in it the heating pipes, which are at 2-ft. centres, themselves form the supports for the panels. As with other ceilings, the manufacturers of heated ceilings

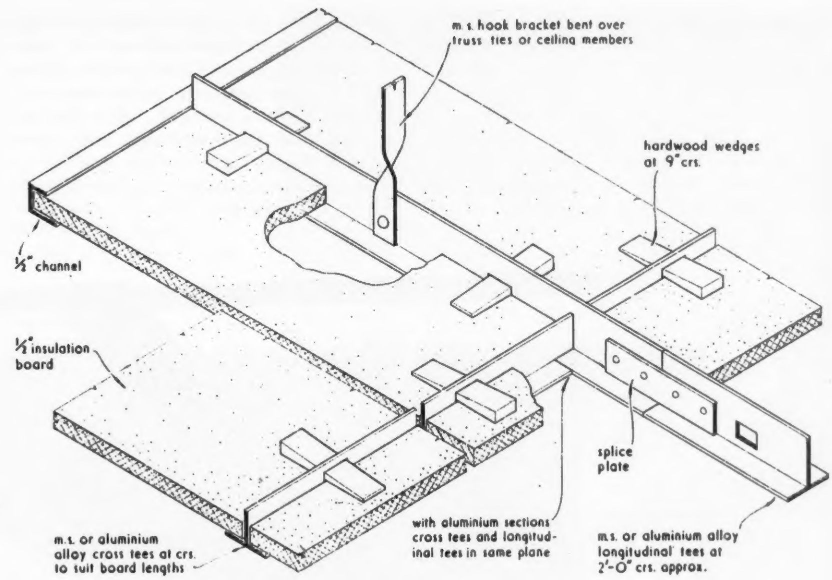


Fig. 7. Wedge method of fixing acoustic ceiling panels to supporting framework of mild-steel or aluminium tees (the Anderson Construction Co. Ltd.). The photograph opposite (Fig. 8) shows an acoustic ceiling by this company into which lighting fittings have been recessed. Additional light is provided by surface-mounted units.

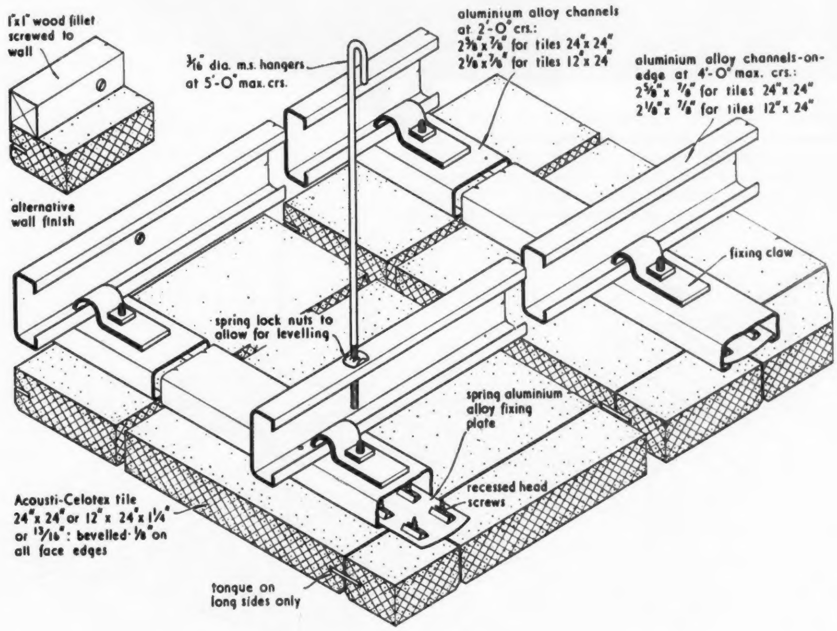


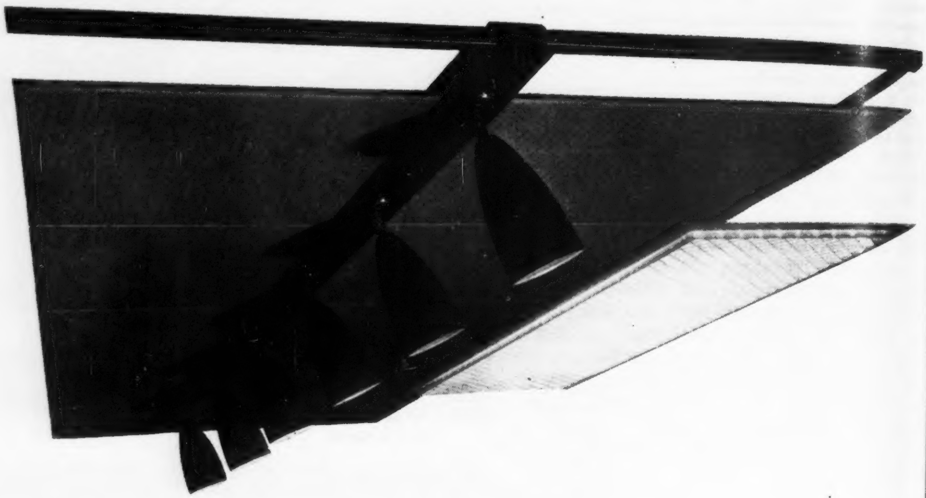
Fig. 9. Secret fixing for acoustic ceiling by the "Cullum" channel fixing system for "Acousti-Celotex" tiles (Horace W. Cullum and Co., Ltd.). The photograph opposite (bottom) (Fig. 10) shows a Cullum installation in a London office. Recessed into the ceiling are A.E.I. "Modular" lighting fittings, each of which takes the place of two ceiling panels.

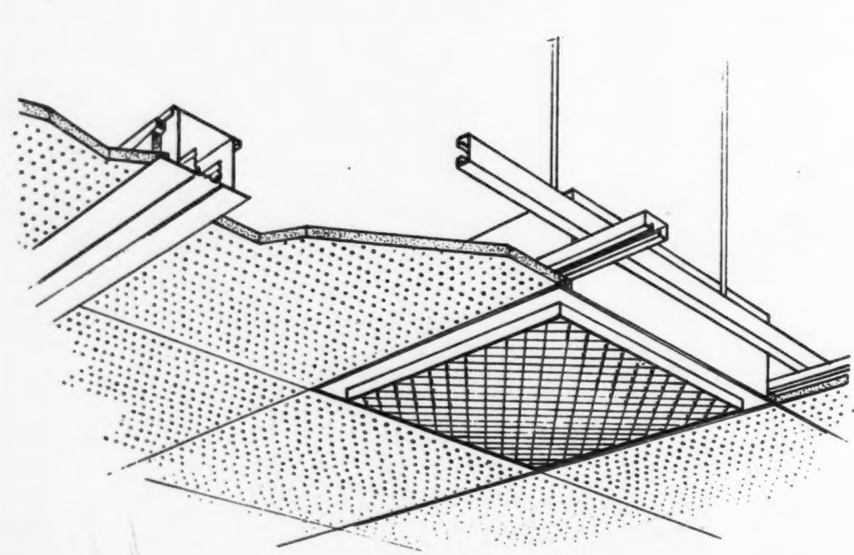
are standardising on the 2 ft. square panel, though the Burgess Products Co. offers 1 ft. x 2 ft. panels as an alternative, and lighting equipment is available which readily integrates with both types. One aspect of this type of ceiling which must be considered by lighting engineers is the loss in efficiency which may be caused by overheating of the lamps in recessed fittings. The normal operating temperatures of fluorescent lamps for maximum lamp output are between 35 and 50 deg. C. (measured on the lamp wall), the ambient temperatures being roughly 28 deg. C. below these figures. Any excess in ambient temperature will produce some loss of output, though the loss will be slight at temperatures up to 32 deg. C. Ceiling temperatures in heated ceilings are often about 38 deg. C., which would produce lamp wall temperatures of approximately 66 deg. C. in free air. When the lamp is enclosed in an unventilated box, higher temperatures can occur, which might easily produce wall temperatures of 70 deg. C. With fluorescent lamps the loss of efficiency caused by this overheating would be about 16 per cent. Care should be taken to ensure that temperatures in heated ceilings are carefully controlled, so that any reduction in efficiency can be calculated and allowed for.

For the surface mounting of lighting fittings on this type of ceiling, various forms

2 continued overleaf

of trunking have been developed, such as "Invertrunking." This particular example is designed to fit into the depth of the suspension system so that a completely integrated effect can be gained (see Figs. 11 and 12). Once "Invertrunking" is installed, it is possible to support lighting units and other forms of electrical equipment, together with their associated wiring, at any point along its length. Hence, fittings can be installed and serviced without alteration to the ceiling panels, and modification to the lighting can easily be made when the use of the rooms is changed. This has the advantage that the appearance and decoration of the ceiling, which often suffers at the hands of the electrician and the maintenance man, is unaffected.





Above and left, Figs 11 and 12, the use of "Invertrunking" for the surface mounting of lighting fittings and for supporting an acoustic ceiling. Note how the use of this continuous trunking does not interfere with the use also of recessed fittings.

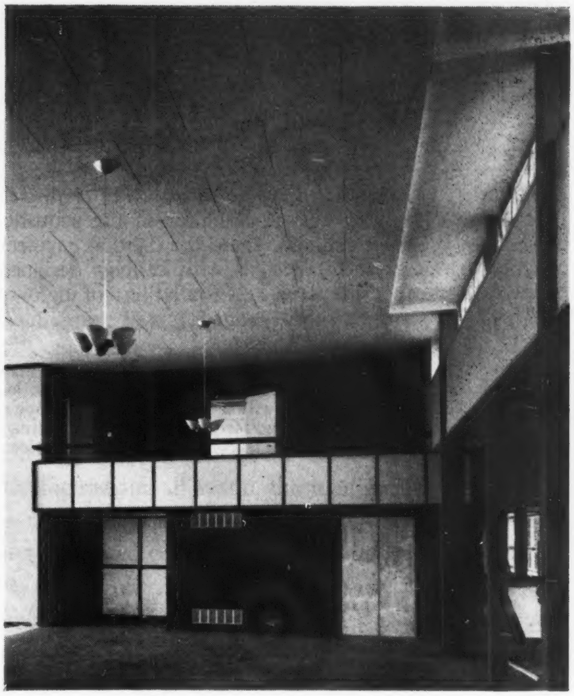
3 fireproof ceilings

The design of new lightweight floor and roof construction makes it necessary to protect the structure from fire. Fireproof ceilings have been developed to meet this need and, since these can be suspended at any reasonable distance below the structural framing, it is possible to integrate other services in the ceiling. The "Modulux" ceiling, made from "Asbestolux" (see Figs. 13 and 14), is a fully engineered ceiling which provides four-hour fire resistance. To a limited extent, it also provides sound absorption. Lighting units may be recessed into the ceiling depth but, if

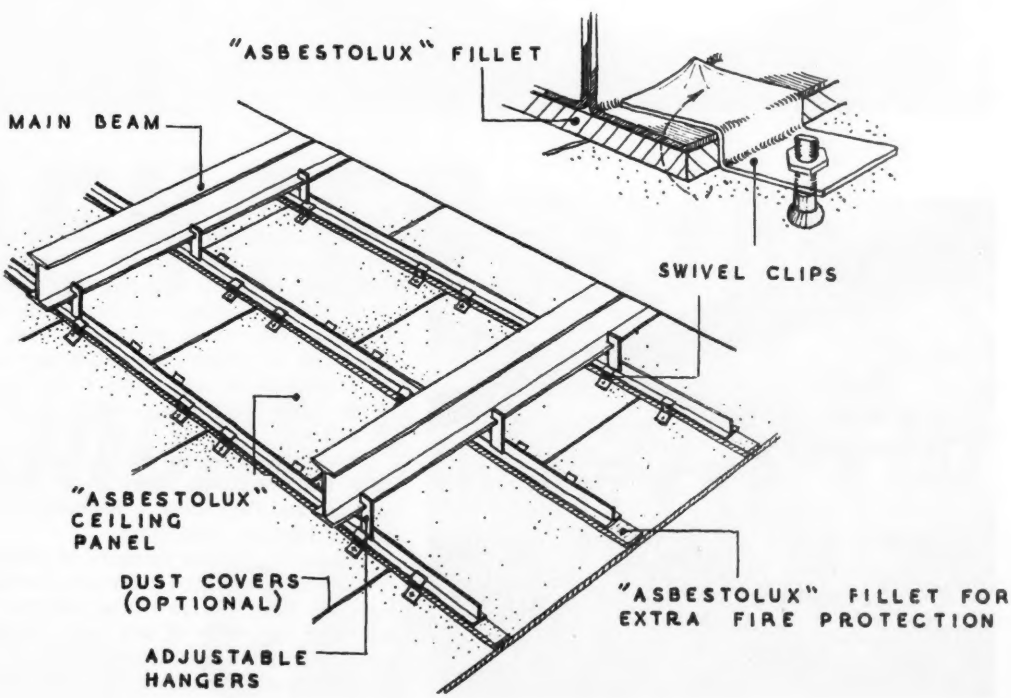
there are many of them, these, too, must be protected. It is advisable, therefore, that the recessed units should themselves have the same fireproofing qualities as the "Asbestolux." As with certain other forms of suspended ceiling, the lighting equipment must be supported from the main structure above. The existing law regarding openings for lighting units in fireproof ceilings is still undefined, but American practice suggests that if the openings do not add up to more than 0.5 per cent. of the total area, no additional fireproofing is required. With high illumination levels, however, 7 per cent. or more of the total area may be required, if recessed lighting units are used.

As recessed fittings offer slightly greater difficulties with fireproof ceilings than with other forms of acoustic ceiling, it has generally been the practice to surface mount the lighting fittings for "Modulux" ceilings, and for this purpose trunking may again be used (see Fig. 15). The trunking can act both as a support for the lighting and other electrical equipment and as a conduit for the wiring.

Fireproof ceilings eliminate the need for other, heavier methods of fireproofing steelwork, such as concrete, which contribute nothing but their own weight, and as it is a dry form of construction it is quick to erect. A logical development would be to design the ceiling so that its profile acts as a reflector to the light source and, at the same time, cuts off the view of the source from general viewing angles. This would overcome the difficulty of making openings for recessed lighting units, and it should prove less costly, as it would obviate the necessity for expensive fittings. An installation based on the above lighting principle is that by Frenger Ceilings Ltd. in the chemical laboratory of C. A. Parson's Heaton Works, where curved panels have been used (see Figs. 16 and 17), but this itself does not incorporate fireproofing.

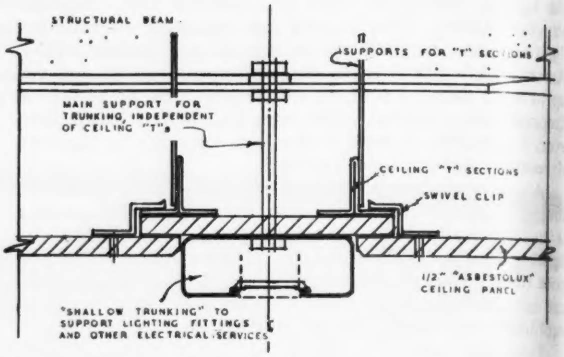


Above, Fig. 13. the use of the "Modulux" ceiling which provides 4-hour fire-resistance, with suspended lighting fittings (Peterlea County Primary School, Fairwater, nr. Cardiff). Below, Fig. 14, diagram of "Modulux" ceiling system, showing use of swivel clips to fix panels to supporting tees.

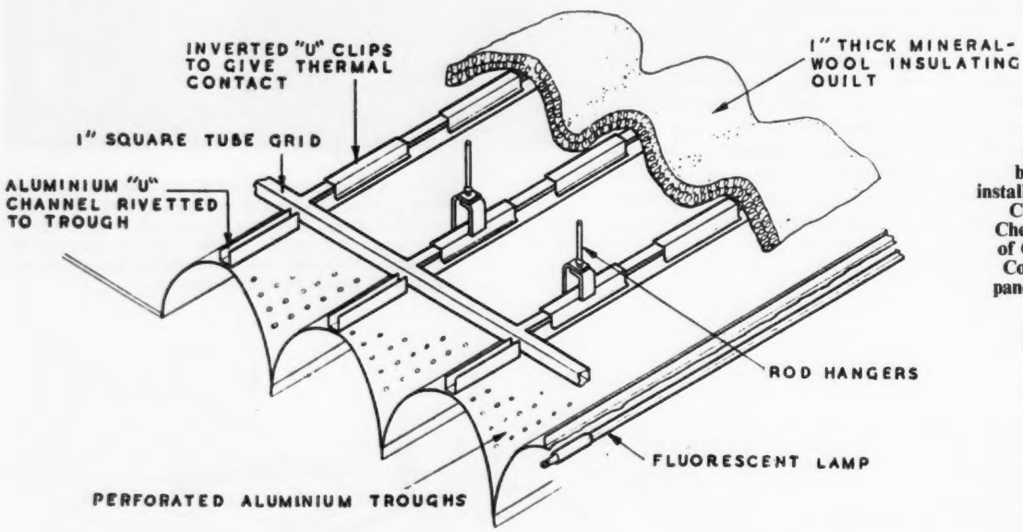


prospect

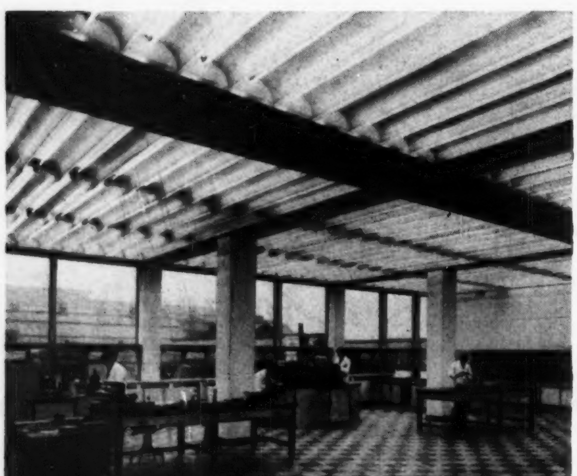
An analysis of the three types of suspended ceiling described above shows that only in the first—the luminous ceiling—has the lighting engineer been primarily concerned in the initial design. This may be the cause of the slight over-emphasis on lighting as an environmental feature in this instance, and the lack of emphasis in the acoustic, heated and fireproof ceilings, where the lighting engineer has had to integrate his designs with ceilings designed primarily for other purposes. Installations of lighting equipment recessed into these latter forms of ceiling have



Right, Fig. 15, the use of A.E.I's "Shallow Trunking," in conjunction with a "Modulux" fire-resistant ceiling, for supporting lighting fittings and other services.



Left, Fig. 16, and below left, Fig. 17, installation by Frenger Ceilings Ltd. in the Chemical Laboratory of C. A. Parsons and Co. Ltd. The ceiling panels, being suitably curved, act as reflectors for the fluorescent lamps.



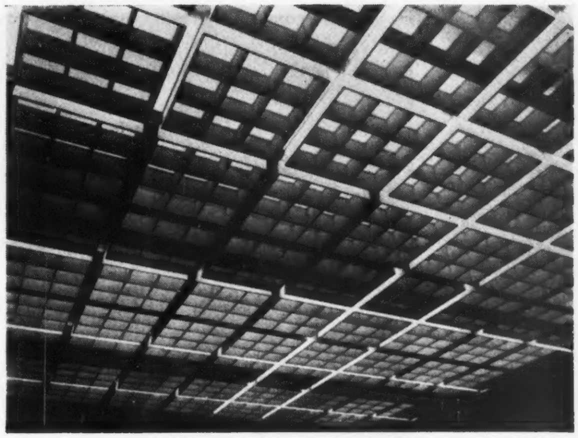
been criticised on the ground that the fittings are uncomfortably bright and the ceiling too dark. This largely depends on the overall level of illumination required and the nature of the floor and other reflecting surfaces. A single recessed fitting in a large area, with a dark floor, will leave the ceiling unbearably dark but, as illumination levels are raised and more fittings are needed, even if the brightness of each fitting is the same, the brightness of the ceiling by reflection will be raised nearer to that of the fitting.

Recent installations, such as that illustrated in Fig. 10, show that where the flooring and furniture is of a light material and the ceiling is decorated in a light colour, the general effect is satisfactory.

There is a further category of suspended ceiling—the special ceiling designed to serve the needs of one particular building. This is of particular interest, as it has resulted not from the needs of any one "service," but from an attempt by the architect concerned to answer *all* the requirements of the building. The most widely used design is

the louvred ceiling of the " Rotterdam " type. First developed for use in an existing store, that of Vroom and Dreesmann in Rotterdam, this is an attempt to conceal a structural ceiling and existing duct-work by suspending a series of large louvres at a lower level and by painting the actual ceiling above black or very dark-blue. Lighting units are then placed between the louvres giving light only in a downwards direction. The effect can be quite dramatic and this type of ceiling has been used in a number of European stores.

A small installation of this type was illustrated in the March, 1956, issue of *Light and Lighting* (pages 73-75); a larger installation is that in the basement of the Owen Owen store, Coventry (*Light and Lighting*, February, 1955).

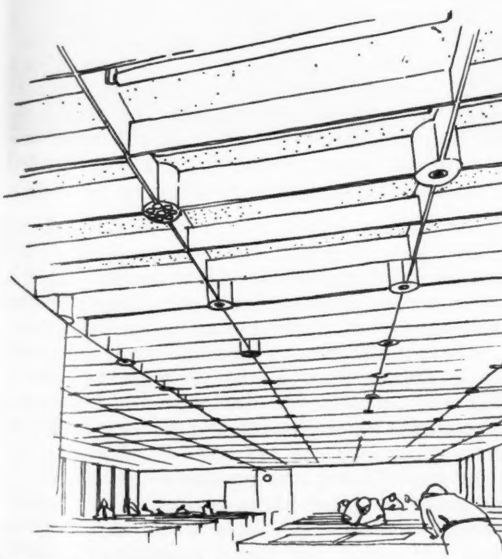


" Treetex " ceiling (Treetex Ltd.) at the Amsterdamse Bank, Rotterdam, in which louvres for reducing glare of artificial light act, during the day, as baffles for natural light from the laylight above.

Other suspended ceiling installations for offices

In offices other methods of providing " tailor-made " suspending ceiling installations have been adopted. One of the most interesting is that in the offices of General Motors at Detroit, designed by Eero Saarinen (see sketch below) where the louvres are suspended below an acoustic ceiling, on which 4-ft. fluorescent lamps are mounted. The size of the lamps dictates the size of the louvre grid, and at the junctions of the louvres specially designed joints are arranged to take sprinkler units and, where necessary, high-speed air ducts. Where special treatment is desired, as in the small lecture theatre (see page 269) the areas between the louvres are filled in with corrugated diffusers.

This type of installation is highly efficient, as it uses the ceiling as a reflector, while at the same time cutting off the view of the lamps which might cause glare. It does not suffer from the criticism of recessed lighting (that the rest of the ceiling appears dark), as the whole of the ceiling and the louvres are all relatively bright, though no surface at the angle of normal viewing is overbright.

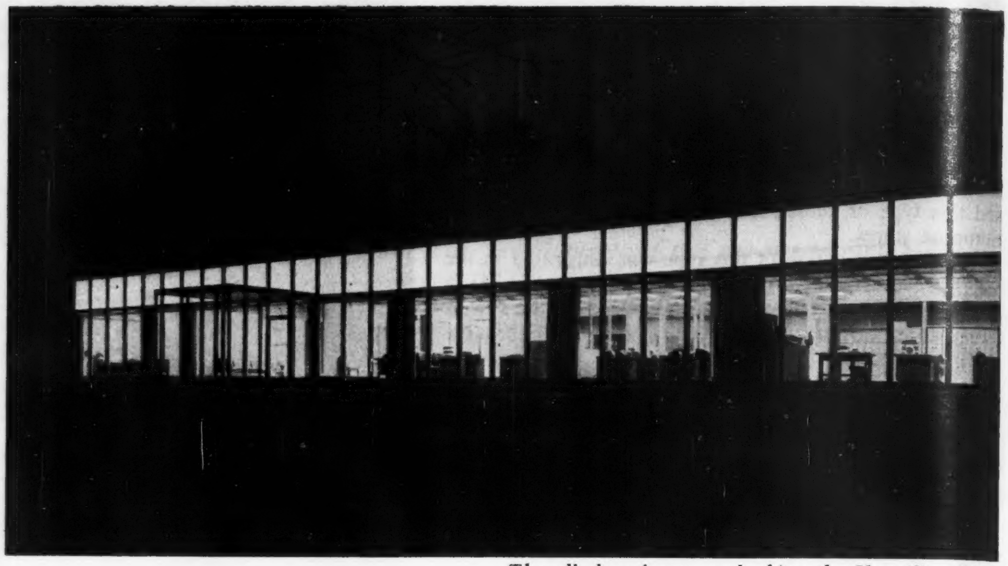


Drawing office at General Motors, Detroit, in which louvres are suspended below an acoustic ceiling on which 4 ft fluorescent lamps are mounted. See also sketch on page 269.

A further example of this type of installation is the Treetex ceiling in the Amsterdamse Bank (see illustration above), in which the louvres act as baffles for the daylight entering through a laylight, while artificial lighting points are placed between them on a rectangular grid. The effect during the day is the overall flashing of the louvres; at night the louvres are darker, with the rectangular grid of the artificial lighting brightly lit.

Mature handling of fluorescent lamps with suspended ceilings

The concourse ceiling of the passenger-handling building at London Airport (see *Light and Lighting*, September, 1955) is a " special ceiling " of particular visual interest, though the system of lighting which gives it its form is not intended to be highly efficient measured solely in light output. The ceiling is formed of slotted fibrous-plaster panels supported from the roof beams. To vary the pattern of light, the panels are placed at alternate angles of 4 degrees to the horizontal. Fluorescent lamps are housed in the sides of the beams, which act as a cornice. This ceiling, and others like it, such as the B.R.S. design for the Birmingham Art Gallery, are showing a new maturity in the handling of the fluorescent lamp in conjunction with suspended ceilings. There is a realisation that light and the form of the ceiling can do more than merely illuminate a space to a given intensity; if planned together and considered as a part of the formal qualities of the building, they can become a major element of the aesthetic environment.



The all-glass front overlooking the Vermilion River valley.

A High Frequency High Voltage Lighting System

A description of a new fluorescent lighting installation in the new office building of the Wakefield Company, at Vermilion, Ohio.

Methods that are unprecedented in applying high-frequency and high-voltage current are used to light a new office building and extension to the Wakefield Company's plant at Vermilion, Ohio, U.S.A. In addition to their utilisation by the company engineers in product development the new areas provide a full-size in-service exhibit and demonstration of every type of commercial and industrial lighting equipment made by the company in its fiftieth anniversary year.

The office building was designed in part as an architectural showcase for one type of contemporary Wakefield lighting equipment, which is shown in the kind of setting for which it was designed. The building is single storey, 42 ft. x 125 ft., of steel, concrete and tan brick with a full front of glass overlooking a deep valley. The west and south walls are solid masonry to protect against afternoon heat and sky glare. The Wakefield Company has stressed the importance of the working environment for so long that the company had to provide near-perfect luminous, thermal, and acoustical conditions. The building commemorates the company's first half-century of operation.

Multi-functional Ceiling

A multi-functional suspended ceiling extends throughout the office interior, providing 100 lm/ft^2 at the inner wall. It contains sprinkler heads, and it distributes conditioned air through acoustical baffles that reduce office noise. The bottoms of the baffles contain receiving channels that mesh into the tops of steel and steel-glass movable partitions on 4-ft. modules. It is known as Wakefield's Sigma-type architectural unit.

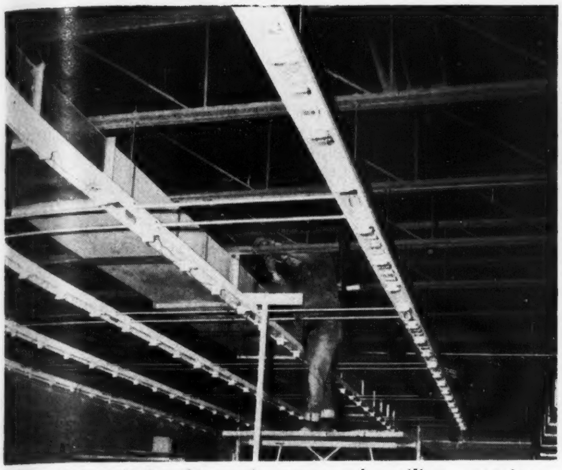
The light diffusers are of rigid-arched "Plexiglas" framed in aluminum to swing down for lighting maintenance or to reach other services concealed above the diffusers. The reflecting secondary ceiling between the diffusers and structural ceiling is painted white with 80 per cent. reflectance. Power is from the Wakefield High Frequency Lighting System, delivering 400 volts at 840 cycles.

High Frequency System

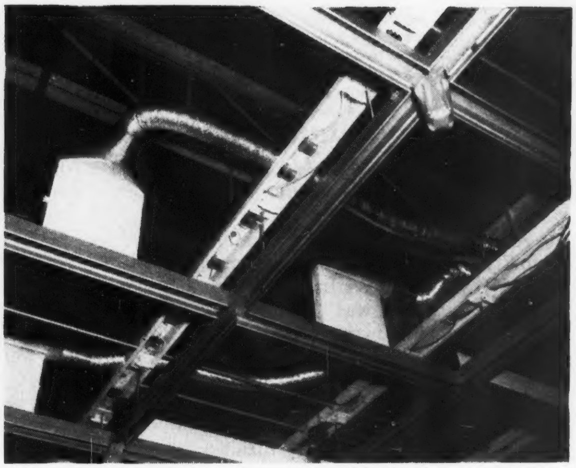
The main advantage of the high frequency system is economy. Savings are both direct and indirect, starting with the lower cost of a small capacitor-type ballast compared with the larger conventional kind, the small capacitor producing 8 to 12 per cent. more light from a lamp operated on 400 volts/840 cycles than the same lamp operated with a conventional heavier ballast on the normal local supply of 118 volts/60 cycles.

In this installation it was possible to use two 400 or 600 ma. lamps per panel where three would be required conventionally. Each extra lamp would have required its ballast and socket, and future re-lamping would, of course, have been increased 50 per cent. over the two-lamp system. Laboratory tests indicate that high-frequency operation increases lamp life by 12 per cent.; this is one of the many factors that will be closely studied now that the installation is in service.

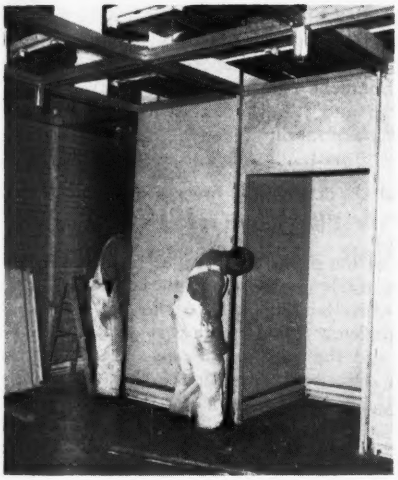
Other advantages are that wiring is simplified—only



Showing relationship of structural ceiling, service facilities in the plenum area for lighting, air conditioning, noise control, sprinkler system.



Showing the lighting channels suspended by rods from the structural ceiling, below the air ducts and pipes for sprinklers and above the office space dividers.



Partitioning being put into place.

A section of the completed installation.

one simple capacitor to start and operate the lamp; one-fifth as many circuits are required for distribution; size of distribution panels are materially reduced, and in some cases panels are eliminated entirely; power consumption is reduced between 10 and 20 per cent. depending upon type of lamps used.

Due to the reduction in size and weight of ballasts, there are also direct economies in shipping and secondary reductions of costs in channel sizes and dead load on the structural ceiling. Even the air conditioning system is affected. In this building it was possible to install equipment of 25-ton capacity rather than a 30-ton system that would have been necessary with large ballasts generating more heat.

Operating Costs

Based upon the electric power rate earned by Wakefield in its entire plant and office operation, this office building costs 24 cents an hour for lighting and 21 cents an hour for air conditioning. On a per person basis, the lighting costs 0.008 cents per hour for 31 persons occupying the office. There are 310 of the translucent diffusers; the cost of bringing wiring and a switch to one of them in a closet would have been much more than to allow closet lights to burn continuously during office hours.

Plant Extension

The newly occupied single-storey addition to the plant is 60 ft. x 201 ft. The production area is lighted by Wakefield's continuous-row fluorescent equipment with 30 per cent. upward and 70 per cent. downward components, utilising 480 volts at 60 cycles to provide 50 lm/ft^2 at the working plane.

The primary side of the ballast is served by a 480-volt, three-phase, 60-cycle electrical distributor serving the 8-ft. lamps. By using 480 volts it was possible to omit three lighting panels, three 10-kva. transformers and 40 lighting fixtures. There were additional saving in labour and costs of the heavier wire that would have been needed had the current been stepped down to 110 volts.

Lighting Abstracts

OPTICS AND PHOTOMETRY

346. Visibility of office tasks. 612.843.6

W. S. FISHER and H. M. SCHMIES, *Illum. Engng.*, **51**, 459-466 (*June*, 1956).

A Luckiesh-Moss visibility meter was used to assess the visibility of 600 clerical and drawing office visual tasks when viewed from 14 inches under an illumination of 20 lm/ft^2. Particular attention was given to the visibility of typewriter carbon copies, handwriting, duplicated material and drafting. The visibility data obtained from the meter readings were related to equivalent sizes of Bodoni Book Monotype. A scale is given which enables Bodoni type sizes to be converted into relative levels of illumination. Absolute levels are also given based on the recommended illumination for a particular reference task. P. P.

612.843.5

347. Subjective thresholds of flicker fusion under various working and test conditions.

E. GRANDJEAN and K. BATTIG. *Helvetica Physiologica et Pharmalogica Acta,* **13**, 178-190 (*Nr.* 3, 1955). *In German.*

The subjective thresholds of flicker fusion of an intermittent light source have been found to be lowered during working hours with certain visual tasks. The reductions are statistically significant at the 0.1 per cent. level. Difficult visual tasks produce the greatest effect, which is diminished if the lighting conditions are improved by reducing harsh contrasts in the peripheral field. Physical work produces no effect. A difficult reading task performed with one eye, the other being occluded, resulted in a reduction in the c.f.f. for each eye indicating that the changes in c.f.f. during strenuous visual work must be connected with a central nervous process. The introduction of rest-periods reduces the magnitude of the effect. It is concluded that the comparison of the c.f.f. before and after work which entails eye strain is a valid measure of the degree of visual effort.

R. G. H.

LAMPS AND FITTINGS

348. Luminaire spacing for end and side walls. 628.93

J. F. FINN, *Illum. Engng.*, **51**, 450-452 (*June*, 1956).

Comments are made on the recommendations given in the American I.E.S. Lighting Handbook for the spacing of luminaires relative to the side and end walls of a room. To ensure adequate illumination without shadowing of desks located close to the walls, the suggestion is made that fluorescent luminaires should be spaced no more than 2 ft. 6 ins. from the side walls with their ends between 6 ins. and 1 ft. from the end walls. P. P.

621.326

349. Measurement of the surface temperature of filament lamps.

K. H. GEHM, *Lichttechnik*, **8**, 301-303 (*July*, 1956). *In German.*

This paper from the Physikalisch-Technische Bundesanstalt (the W. German National Laboratory) describes a research on the measurement of the bulb temperature of filament lamps, with particular application to the temperature rise in a flame-proof fitting. The measurements are made with copper-constantan thermocouples and the effects of the bulk of the attachment and of the gauge of wire used were first investigated so that the values obtained in the main research could be corrected. It was found that the maximum temperatures reached were considerably lower for a pendent lamp than for the same lamp in any other burning position. A number of curves of temperature distribution are given.

J. W. T. W.

LIGHTING

628.972

350. Modern operating theatre lighting in the Karolinska Hospital.

S. SWARD, *Ljuskultur*, **28**, 29-32 (No. 2, 1956). (*In Swedish.*)

A cupola 12 ft. in diameter has been built over the operating theatre and provided with windows through which the operation can be studied. Sixty fixed projector fittings are built into the cupola, while the apex of the cupola, which contains seven projectors, can be manoeuvred by remote motor-driven control. Two groups of fixed projectors are mounted in opposite walls. The installation is designed to give a wide adjustment of high-level (2,500 lm/ft^2) shadow-free lighting on the operating table. Special glass filters to remove heat rays, and a temperature rise of only 30 deg. C. after an hour is reported for the focal point of the system. Filament lamps (72-watt, 24-volt) are used throughout. Lamp and fittings can easily be changed or cleaned from the observation room. R. G. H.

628.975

351. Problems of airport lighting for approach and landing.

G. SPRINGER, *Lichttechnik*, **8**, 215-218 (*May*, 1956). *In German.*)

The first part of the paper is a detailed description of the different methods used to assist a pilot when approaching an airfield and when landing, with particular reference to visual aids. Completely blind landing is an ideal not yet fully attainable, and the various systems of approach and landing lights are described, in particular those used by the United States (ALPA-ATA system), Gt. Britain (Calvert), France and by the German Luftwaffe during the war. The lines along which progress is specially desirable are indicated, and the need for easing the transition from instrument to visual approach is emphasised. J. W. T. W.

628.972

352. Recommended practice for office lighting.

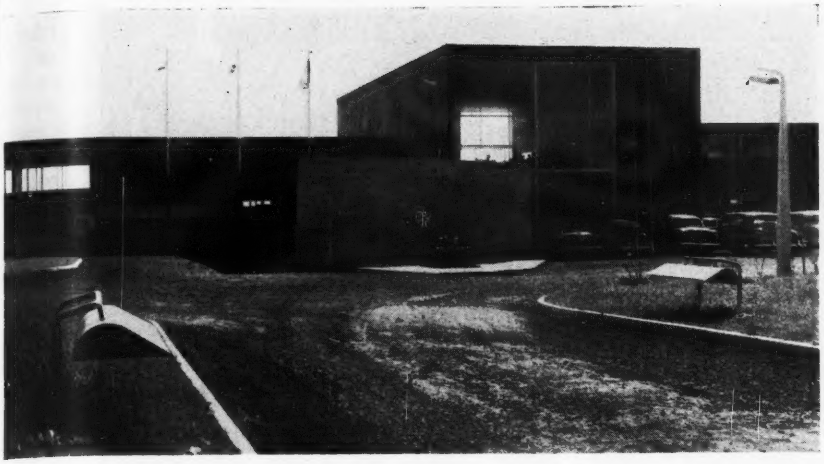
Illum. Engng. **51**, 419-445 (*June*, 1956).

Prepared by the Office Lighting Committee of the American I.E.S., this Recommended Practice supersedes that published in 1948. Illumination levels recommended for various categories of office task are tabulated and attention is given to the numerous factors which determine the quality of office lighting. The basic characteristics of lighting an interior by natural and artificial means are considered and the problems associated with lighting and seeing in specific office areas are dealt with in detail. P. P.

353. Esthetics of office lighting layout. 628.972

G. P. WAKEFIELD, *Illum. Engng.*, **51**, 453-456 (*June*, 1956).

Having defined "esthetics" in relation to lighting design as "the pleasing arrangement of lighting elements," consideration is given to the ways in which luminaires can be distributed so as to be considered aesthetically acceptable in offices of square or rectangular shape. Luminous ceilings offer a particular problem because of the larger luminous areas involved and the higher apparent brightness contrasts displayed. P. P.



General view from north, looking toward main entrance and window-wall of concourse, with Customs hall on left and offices on extreme right.

Terminal Buildings at Turnhouse Airport, Edinburgh

Architect, Robert H. Matthew, C.B.E., F.R.I.B.A. (chief assistant, T. R. Spaven, A.R.I.B.A.); electrical consultant, Ian Hunter and Partners; main contractor, Nathaniel Grieve; electrical installation, James Scott and Co., Ltd.; lighting fittings, The Merchant Adventurers, Ltd., Frederick Thomas and Co., Ltd.

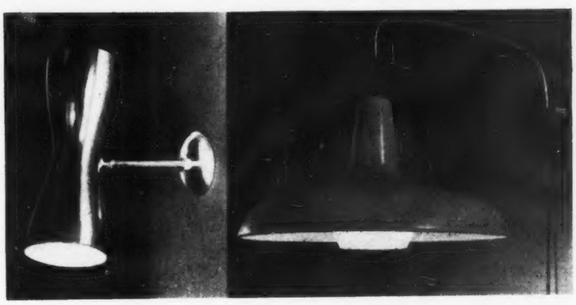
THIS new building replaces passenger facilities in premises now needed for Air Ministry purposes, Turnhouse being a permanent R.A.F. station. The site is almost level, the immediate surroundings being featureless, but there are good views to the south. Access is from the main Edinburgh-Stirling road.

The main elements in the design are (a) the concourse —a general public area with traffic offices, passenger-handling facilities and waiting space on the ground floor, and a buffet and bar on the first-floor balcony; (b) the Customs hall, which is to the east of the concourse, being separated from it by the Customs offices and baggage-circulation corridor; and (c) two storeys of offices for M.T.C.A. and airline staff, to the west of the concourse. The plan is such that both the concourse and the Customs hall may later be extended, the former northwards and the latter to the east. The offices, too, could be extended both westwards and northwards.

The passenger-handling accommodation is arranged so that the passengers proceed by a direct route from the main entrance to the aircraft. Their baggage moves separately, the two circulation routes meeting at the "processing counters," where both unaccompanied baggage and hand baggage is checked and weighed. Thereafter passengers for destinations in the United Kingdom wait until instructed to join the aircraft, while passengers for foreign destinations proceed to the Customs.

The Customs hall comprises an examination area and a waiting-room; it can be divided by a sliding-folding partition to allow the simultaneous handling of outgoing and incoming passengers. The Customs officers must have a clear view of the aircraft as they land and taxi, and their offices are, therefore, on the "air side" of the building.

The load-bearing structure is a conventional frame of rolled-steel stanchions and beams, the concourse has a welded portal frame, and the workshops load-bearing walls of brick and stone. External walls, from the foundations to 3 ft. above ground level and on certain



Left, wall fitting, with diabolo-shaped spun-aluminium reflector housing 60-watt tungsten lamp —used in main concourse. Right, adjustable wall fitting, with white-opal glass bowl housing 60-watt tungsten lamp and 16-in. dia. stove-enamelled spun-aluminium reflector—used in ladies' rest room.

The main concourse seen from beneath the balcony-buffet, looking toward the "processing counters." The main entrance is on the extreme left.

gables, are of natural sandstone or bricks made from pulverised fuel-ash, with white cement-lime-sand pointing.

Partitions are mostly of 3-in. lightweight concrete, finished with hardwood panelling in the concourse, glazed tiles in public lavatories, and painted plaster elsewhere. The hardwood panelling, also used (on softwood framing) for the inner skin of the external walls, is of 1-in. beech and mahogany, treated with wax polish or phenolic resin.

The ground floor slab is of mass concrete, finished with gurjun strip in the concourse, quarry tiles in lavatories, granolithic in stores and thermoplastic tiles elsewhere. Roofs are of fully-supported 20-s.w.g. super-purity aluminium, laid on roofing felt and boarding, carried by timber rafters on rolled-steel purlins. The roof terrace is covered with 12-in. square asbestos-cement tiles on 3-ply bituminous felt and a lightweight concrete screed.

The concourse ceiling is of 13/16-in. rabbit-warren fibreboard, secret-fixed to aluminium T-sections and treated with fire-retardant and water paint. Elsewhere, ceilings are mostly of $\frac{3}{4}$-in. V-jointed fibreboard, similarly treated but finished with emulsion paint. In the entrance vestibules the ceilings are of 1-in. tongued-and-grooved hardwood, fixed to softwood framing and wax polished. A similar treatment has been given to the soffit of the balcony buffet.

Insulation and Services

Thermal insulation in the form of a 1-in. glass-fibre quilt has been provided behind all hardwood wall panelling, and $\frac{3}{4}$-in. insulation board has been used under the aluminium roofing. Double doors and vestibules at the main entrances keep down heat losses due to frequent air-changes. Noise levels in the concourse, buffet and Customs hall have been minimised by the absorbant ceilings described above and, in some areas, by the use of fitted carpets.

Hot water for the cabinet heater units used in the main concourse and Customs hall and the hospital-type radiators elsewhere is provided by two cast-iron sectional boilers, each rated at 445,000 B.Th.U./hr., heated by automatically controlled oil burners. The cabinet heaters provide a quick reaction to fluctuating heat demands and the warmth from them is supplemented by radiant panels below the concourse "window walls."

The tender cost of the building (July, 1954) was £65,430, excluding external works—i.e., 5s. 1$\frac{1}{4}$d. a ft. cube or 91s. 5d. a sq. ft.

Daylighting

Large areas of glazing at both ends of the concourse, part of which is 26 ft. high, provide a high level of illumination and give waiting passengers good views of arriving and departing aircraft. Offices, too, have large windows, extending the full width of their external walls; the minimum of glazing bars needed to provide adequate opening lights leaves each office a "picture window" nearly 8 ft. wide and 6 ft. deep.

The Customs hall is lit by day by a high-level window the full width of the north wall. The sill height is 10 ft. above floor level and the depth of the window 6 ft. 6 in. It provides concentrated northlight just where it is needed

—along the 30-ft. examination bench which stands parallel to the external wall.

The large windows to the concourse and Customs hall are glazed with $\frac{3}{8}$-in. polished plate glass in aluminium frames and pressed aluminium surrounds. Elsewhere glazing is mainly of $\frac{1}{4}$-in. plate glass or prismatic glass, also in aluminium frames, but with hardwood surrounds.

Artificial Lighting

Artificial lighting for the concourse, the buffet and the Customs hall is mainly by circular fittings recessed into the ceiling and housing tungsten lamps—60-watt in the concourse and on the balcony, and 100-watt in the Customs hall, where a higher level of illumination is needed. These fittings serve also as outlets through which stale air is drawn by electrically operated fans. In the concourse the recesses in the ceiling are $7\frac{1}{2}$-in. dia. and the spun-metal reflectors $4\frac{1}{2}$-in. dia. Perforations in the side of the reflector throw light on to "Perspex" louvre rings fixed in the space around it. In the Customs hall the ceiling recesses are 9-in. dia., while the reflectors are 6-in. dia. A standard fitting of similar design, but covered with a dished prismatic lens, is used in the offices, corridors and lavatories.

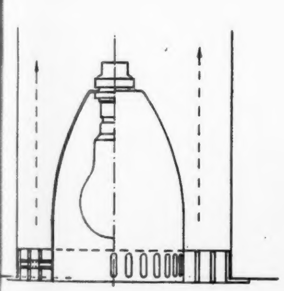
Supplementary light and "sparkle" is provided in the concourse by diabolo-shaped wall fittings, each housing two 60-watt tungsten lamps; in the buffet by table lamps fixed to the balustrading; in the offices by desk lamps; and elsewhere—e.g., over the processing counters—by wall-mounted spotlights with spun-metal reflectors. All these fittings, except those in the buffet, are from manufacturers' standard catalogues.

Other specially designed fittings include a wall bracket unit, extending 12 in. from the wall and housing a 13-ft. row of architectural lamps. Made in three parts bolted together on the site, the fitting lights a poster display board.

External Lighting

External lighting of roadways is by fittings at ground level (seen in the photograph on page 283). These were designed to prevent light from shining upwards, which might confuse pilots of approaching aircraft. The stove-enamelled reflectors are 4 ft. 6 in. long and 1 ft. 9 in. wide; they house four 200-watt tungsten lamps.

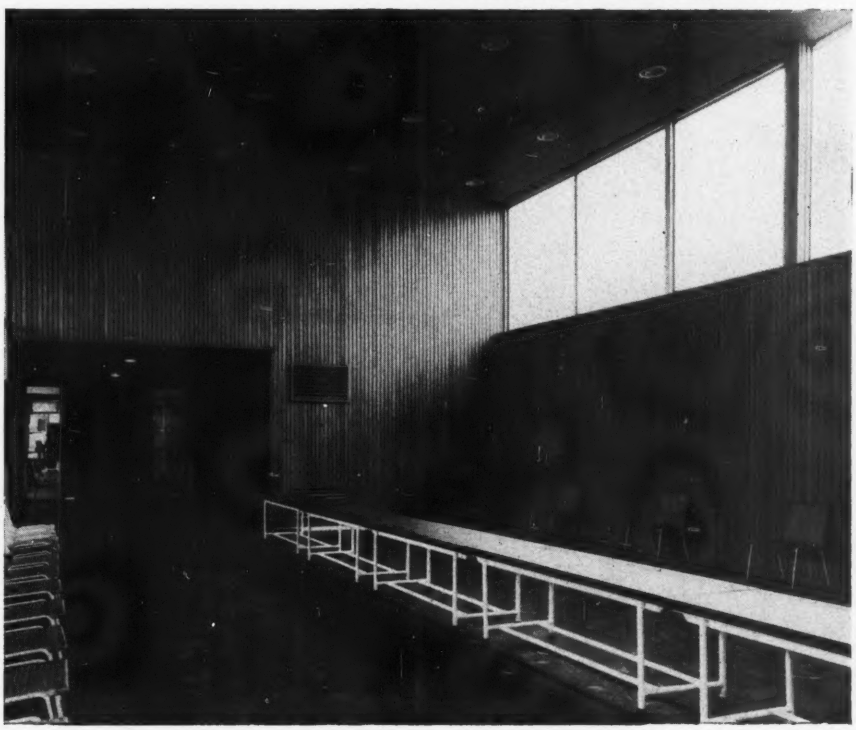
The power supply is 415/240 three-phase, four-wire, 50 c/s from a local sub-station. It is distributed from a main switch panel to sub-main switches; thence to local fuseboards and points. Switchgear and distribution boards are of the totally enclosed ironclad type, with H.R.C. fuses. Switches and switch/socket units are enclosed in cast-iron boxes; flush plates are of cadmium-plated steel.



Section through combined ventilation grille and lighting fitting as recessed into ceilings of concourse and Customs hall.

Section through fitting for architectural lamps used to light poster display board.

The Customs hall, showing examination counter and main north window. The corridor on the left leads to the concourse and to the Customs offices.



Passenger Waiting Hall, Southampton

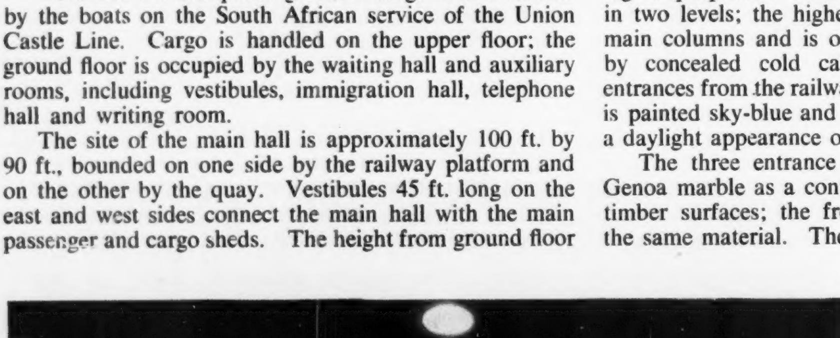
Main contractor, Trollope & Colls Ltd.; interior, Heals Contracts Ltd. (designer-in-charge, A. W. Skeels); lighting fittings, Falk, Stadelmann & Co., Ltd., Troughton & Young (Lighting) Ltd.; cold cathode tubing, Ionlite Ltd.

Exterior of the building from the quay.

THE new passenger and cargo building at 102 Berth in the new docks at Southampton is at present in use for inward passenger and cargo traffic carried by the boats on the South African service of the Union Castle Line. Cargo is handled on the upper floor; the ground floor is occupied by the waiting hall and auxiliary rooms, including vestibules, immigration hall, telephone hall and writing room.

The site of the main hall is approximately 100 ft. by 90 ft., bounded on one side by the railway platform and on the other by the quay. Vestibules 45 ft. long on the east and west sides connect the main hall with the main passenger and cargo sheds. The height from ground floor to first floor level is approximately 22 ft., necessitating a suspended ceiling to cover the main beams and to give a good proportion to the main hall. The ceiling is treated in two levels; the higher level is sited between the four main columns and is of a free triangular shape, lighted by concealed cold cathode tubing, thus linking the entrances from the railway and quayside. The lower level is painted sky-blue and the higher level white to produce a daylight appearance over the central area.

The three entrance lobbies are clad in dark green Genoa marble as a contrast in colour and texture to the timber surfaces; the free-standing columns are clad in the same material. The main hall is panelled in natural



General view of the main hall showing the two ceiling levels. The entrance from the railway is on the left and the entrance from the quay on the right.

The entrance to the east vestibule leading to the cargo and luggage shed.

The east vestibule looking towards the main hall showing the dropped ceiling panel concealing cold cathode tubing. The door on the left leads to the immigration room.

Honduras mahogany relieved with a rich Kevassinga in selected areas. Weathered elm, sycamore and teak are used in the ancillary rooms.

To prevent the vertical treatment of panelling and doorways from dominating the scheme, low-level canopy ceilings were introduced round the perimeters of the main hall under the cantilevered mezzanine balconies on either side. The mezzanine levels above also restrict the height of the ancillary rooms, the ceilings of which are all lower than that of the main hall. In the centre of the hall is an island stand used by British Railways and travel agencies.

Flooring is of $\frac{1}{4}$-inch thick linoleum tiles laid in 18-in. squares with a base colour of mountain grey. Contrasting tiles in colour to echo the furnishing fabrics are laid at random to break up the large floor area. Electric floor heating is used throughout.

Lighting

The lighting in the main hall is provided by 124 flush 9-in. diameter tungsten lamp fittings in a regular pattern; each holds a 100-watt lamp. The higher level is indirectly lighted by four lines (675 ft.) of 4,500 deg. K. cold cathode tubing; the lines of tubing are switched in pairs.

The low-level canopies around the perimeter are fitted with specially designed 3-in. diameter recessed 60-watt tungsten lamp fittings; additional lighting is provided over the shipping company's counter by three lines of 3,500 deg. K. cold cathode tubing.

The special 3-in. diameter tungsten fittings are also used over the doors on the railway side and in dropped panels in each of the vestibules. These dropped panels also carry around their perimeter a single line of 3,500 deg. K. cold cathode tubing giving indirect lighting. There is also a single line of cold cathode tubing along the cornice on each side.

Internally illuminated signs at various places in the main hall contain cold cathode tubing.

The illumination levels in the main hall vary from 25 lm/ft^2 near the centre of the hall under the raised ceiling to 18 lm/ft^2 near the walls. The total load is 46 kw., of which 31 kw. is tungsten lighting, and 14 kw. cold cathode, the remainder being hot cathode fluorescent lighting which is used in toilets, etc. In the main hall the tungsten lamp load is 21 kw., and the cold cathode load 8 kw.

The immigration room lighted by recessed tungsten lamp fittings in the ceiling and diabolo wall brackets.

The shipping company counter showing the low level canopy. The sign above the canopy is illuminated by cold cathode tubing.

Surface Distribution Factors and the Split Flux Method

By RONALD CROFT,
B.Sc., A.M.I.E.E.,
Registered Lighting Engineer (I.E.S.)

Using the combination of Surface Distribution Factors[1] to calculate the initial (i.e., non-reflected) components and the Split Flux Method[2] to obtain the reflected components, it is possible to work out the average illumination on the working plane and also average values of the final luminance for the ceiling, walls and floor, without having to refer to the detailed tables of the Inter-reflection Method[3] or the experimental data of the Lumen Method[4, 5].

The first requirement is an intensity distribution diagram for the selected luminaires, from which the indirect, horizontal and direct fluxes, together with the flux ratio for the direct component, can be evaluated. For ease of application it is better to convert from component fluxes to component light output ratios. Just as the light output ratio for the complete luminaire is the ratio of lumens emitted by the luminaire to lumens from the lamp, the indirect light output ratio is the quotient of lumens in the indirect component and lumens from the lamp.

Surface Distribution Factors

In order to calculate the initial illumination on a surface, surface component light output ratios are needed, e.g., ceiling light output ratio, i.e.,

$$\frac{\text{lumens reaching ceiling without inter-reflections}}{\text{lumens emitted by lamp}}$$

Luminaire component light output ratios can be converted to surface light output ratios by multiplying the former by the surface distribution factor, which is the proportion of the luminaire component reaching the particular surface directly, and then adding these products for all the luminaire components affecting the surface in question. The surface light output ratios are determined by the following formulae:—

$$g_m = g_d D_{md} + g_h D_{mh} \quad \ldots \quad (1)$$

$$g_c = g_i D_{ci} + g_h D_{ch} \quad \ldots \quad (2)$$

$$g_f = g_d D_{fd} + g_h D_{fh} \quad \ldots \quad (3)$$

$$g_w = g - g_c - g_f \quad \ldots \quad (4)$$

where g_m, g_c, g_f, g_w = working plane, ceiling, floor, wall light output ratios,

g, g_i, g_h, g_d = luminaire, indirect, horizontal, direct light output ratios,

D_{ci}, etc. = ceiling distribution factor for indirect component, etc.

The surface distribution factor for a horizontal surface is a theoretically determined relationship between the shape of the intensity distribution curve, the spacing of the luminaire and a function of the distance between the plane of the luminaires and the surface, and the area of the surface. This latter function is analogous to the room coefficient of the Inter-reflection Method and the reciprocal of room ratio of the Lumen Method. For this reason is has already been called[1] the surface coefficient, *viz.*, ceiling coefficient, etc., as the case may be. These coefficients are given by the following formulae:—

$$k_m = \frac{h_m(W + L)}{2WL} \quad \ldots \quad (5)$$

$$k_c = \frac{h_c\,(W + L)}{2WL} \quad \ldots \quad (6)$$

$$k_f = \frac{h_f\,(W + L)}{2WL} \quad \ldots \quad (7)$$

where k_m, k_c, k_f = working plane, ceiling, floor coefficients,

h_m, h_c, h_f = distances between plane of luminaires and working plane, ceiling, floor,

W, L = width, length of room.

There is no coefficient for the walls, because they are vertical surfaces.

The closer the spacing, the more flux is absorbed by the walls and the lower the distribution factor.

Fig. 1 gives surface distribution factors for the indirect, horizontal and 14 classifications of direct components, as a function of surface coefficient. The direct component is classified in accordance with the degree of concentration of its flux output in its 0-40 deg. zone, which is designated flux ratio and expressed as a percentage. The indirect component plays a relatively smaller part in the illumination of the working plane so only one distribution is considered; for simplicity a cosine distribution with spacing to suspension ratios of 1.0 and 2.0 is chosen. The horizontal distribution always being a sine distribution only requires relating to spacing ratio, 0.5, 1.0 and 2.0 being given. Spacing ratios for direct components are 0.5 and 1.0; 1.5 is not included, because even with this, the ratio at the wall, which is really the important thing, is usually 0.5 which is equivalent to a spacing ratio of 1.0.

It might be noted in passing that the surface light output ratios are the equivalent of coefficients of utilisation for the surfaces, when the room has black surfaces, so it is easy to visualise that the initial illumination on the surfaces can be obtained from the following:—

$$E_o = g_m \frac{NFMB}{WL} \quad \ldots \quad (8)$$

$$E_{co} = g_c \frac{NFMB}{WL} \quad \ldots \quad (9)$$

$$E_{fo} = g_f \frac{NFMB}{WL} \quad \ldots \quad (10)$$

$$E_{wo} = g_w \frac{NFMB}{2H(W+L)} \quad \ldots \quad (11)$$

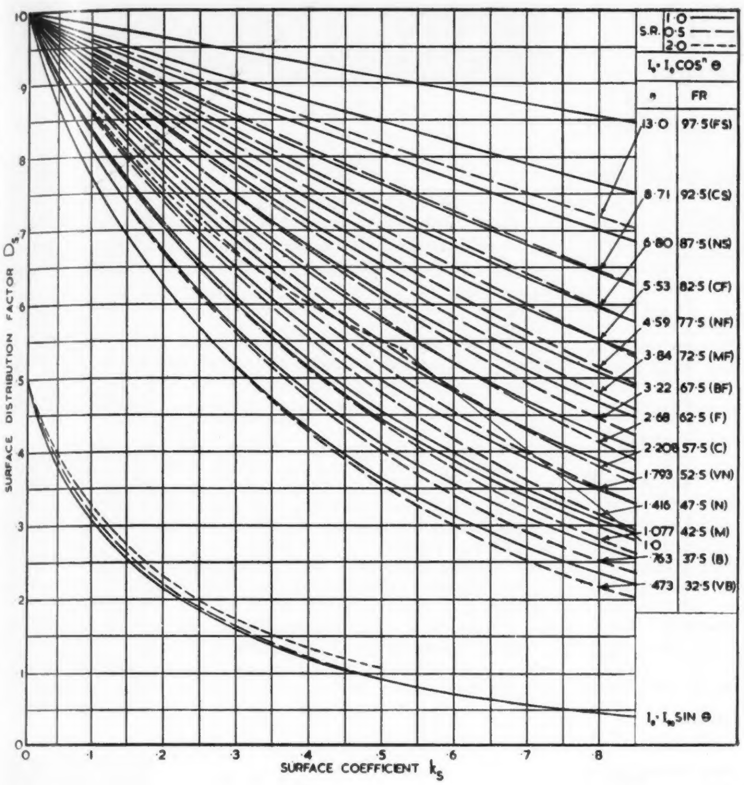


Fig. 1. Surface distribution factors.

where

$E_o, E_{co}, E_{fo}, E_{wo}$ = initial average working plane, ceiling, floor, wall illuminations,
N = number of luminaires,
F = lamp flux in each luminaire,
M = maintenance factor,
B = absorption factor,
H = height of room.

Split Flux Method

This method, as described by Hopkinson(2), calculates the first reflected flux separately for the lower and upper hemispheres, and after adding to obtain the total first reflected flux, the average illumination in any part of the room due to inter-reflections only is obtained approximately using the principle of the integrating sphere.

The use of surface distribution factors enables a more accurate and in some ways simpler determination of the first reflected flux, than is possible by simply splitting into lower and upper hemispheres. The first reflected flux can be calculated separately for the ceiling, floor and walls, as follows:—

$$F_{cr} = \rho_c g_c \ NFMB \quad \ldots \quad (12)$$

$$F_{fr} = \rho_f g_f \ NFMB \quad \ldots \quad (13)$$

$$F_{wr} = \rho_w g_w \ NFMB \quad \ldots \quad (14)$$

where F_{cr}, F_{fr}, F_{wr} = first reflected fluxes from ceiling, floor, walls,

ρ_c, ρ_f, ρ_w = ceiling, floor, wall reflection factors.

In a case where the upper half of the walls has a different reflection factor from the lower half, it can be treated separately, using two wall light output ratios.

From the integrating sphere,

$$E_r = \frac{F_{cr} + F_{fr} + F_{wr}}{A_s\,(1-\rho_s)} \quad \ldots \quad (15)$$

where
E_r = inter-reflected illumination in room,
A_s = total area of room surfaces,
ρ_s = average reflection factor of room surfaces.

Hence,

$$E_r = \frac{F_{cr} + F_{fr} + F_{wr}}{A_c(1-\rho_c) + A_f(1-\rho_f) + A_w(1-\rho_w)} \quad \ldots \quad (16)$$

where A_c, A_f, A_w = ceiling, floor, wall areas.

The final average illumination on the working plane is given by:—

$$E = E_o + E_r \quad \ldots \quad (17)$$

where E = final working plane illumination.

Also the final surface luminances are given by:—

$$L_c = \rho_c\,(E_{co} + E_r) \quad \ldots \quad (18)$$

$$L_f = \rho_f\,(E_{fo} + E_r) \quad \ldots \quad (19)$$

$$L_w = \rho_w\,(E_{wo} + E_r) \quad \ldots \quad (20)$$

where L_c, L_f, L_w = final ceiling, floor, wall luminances.

Example:

The nine luminaires in the room shown in plan and elevation in Fig. 2 have $g_h = .660$, $g_i = -.014$, $g_d = .189$ (VN), each with $F = 1{,}970$ lumens, $M = .8$ and $B = 1.0$. Average reflection factors are $\rho_c = .7$, $\rho_f = .3$, $\rho_{wu} = .7$ (upper 2 ft. of walls), $\rho_{wl} = .46$ (lower 10 ft.). Calculate E, L_c, L_f, L_{wu}, L_{wl}.

$$k_m = \frac{6.5\,(24 + 24)}{2 \times 24 \times 24} = .271$$

Similarly $k_c = .125$,
and $k_f = .375$

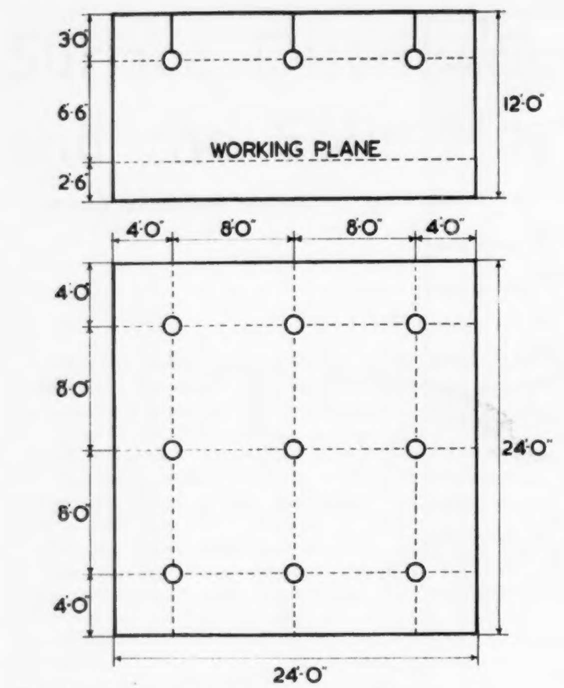


Fig. 2. Room referred to in example.

For separation level between upper and lower walls,

$$k_u = \frac{1.0\ (24 + 24)}{2 \times 24 \times 24} = .042.$$

Using Fig. 1 and taking spacing ratio = 1.0, spacing to suspension ratio = 2.0.

$$g_m = .189 \times .710 + .660 \times .174 = .249.$$
$$g_c = -.014 \times .837 + .660 \times .296 = .183.$$
$$g_f = .189 \times .525 + .660 \times .130 = .204.$$
$$g_u = -.014 \times .938 + .660 \times .412 = .259.$$
$$g_w = .660 - .014 + .189 - .183 - .204 = .448.$$
$$g_{wu} = g_u - g_c = .259 - .183 = .076.$$
$$g_{wl} = g_w - g_{wu} = .448 - .076 = .372.$$
$$\therefore E_o = .249\left(\frac{9 \times 1{,}970 \times .8 \times 1}{24 \times 24}\right) = 6.13 \text{ lm/ft}^2.$$

Similarly $E_{co} = 4.51$ lm/ft².

$E_{fo} = 5.02$ lm/ft².

Also $$E_{wuo} = .076\left(\frac{9 \times 1{,}970 \times .8 \times 1}{2 \times 2\ (24 + 24)}\right) = 5.62 \text{ lm/ft}^2.$$

Similarly $E_{wlo} = 5.50$ lm/ft².

$$F_{cr} = .7 \times .183 \times 9 \times 1{,}970 \times .8 \times 1 = 1{,}818 \text{ lm}.$$

Similarly $F_{fr} = 869$ lm.

$F_{wur} = 755$ lm.

$F_{wlr} = 2{,}426$ lm.

$$\therefore E_r = \frac{1{,}818 + 869 + 755 + 2{,}426}{24 \times 24\ (2 - .7 - .3) + 2\ (24 + 24)\{2\ (1 - .7) + 10\ (1 - .46)\}} = 5.10 \text{ lm/ft}^2.$$

$$\therefore E = 6.13 + 5.10 = 11.23 \text{ lm/ft}^2.$$
$$L_c = .7\ (4.51 + 5.10) = 6.73 \text{ ft/L}.$$
$$L_f = 3.04 \text{ ft/L}.$$
$$L_{wu} = 7.51 \text{ ft/L}.$$
$$L_{wl} = 4.87 \text{ ft/L}.$$

It is interesting to compare the above results with the following obtained from the Surface Distribution Factor—Inter-reflection Method(1) :—

$$E = 11.85 \text{ lm/ft}^2.$$
$$L_c = 6.21 \text{ ft/L}.$$
$$L_f = 3.19 \text{ ft/L}.$$
$$L_{wu} = 7.75 \text{ ft/L}.$$
$$L_{ul} = 4.80 \text{ ft/L}.$$

In general, the agreement is good, and it seems that Hopkinson's prediction(2) of an accuracy of ± 20 per cent. for the inter-reflected component is a fair estimate, so that where there is even a small direct component, the accuracy should be ± 15 per cent.

An advantage of the method is the ease with which the effect of alternative reflection factors can be investigated.

References

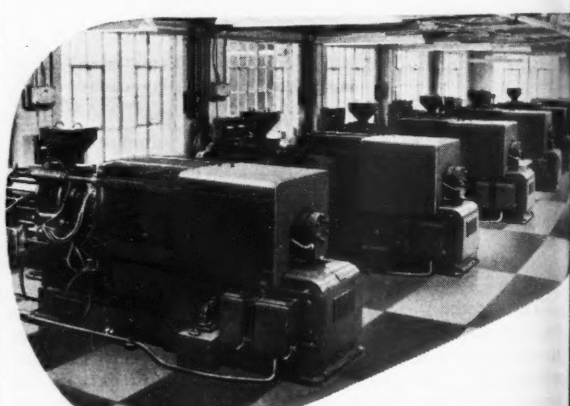
(1) "Surface Distribution Factors and the Inter-reflection Method," Croft, R., Trans. Illum. Eng. Soc. (London), **20**, 259 (1955).

(2) "The Indirect Component of Illumination in Artificially-lit Interiors," Hopkinson, R. G., *Light and Lighting*, **48**, 315 (1955).

(3) "Lighting Design by the Inter-reflection Method," Moon, P., and Spencer, D. E., Journal of the Franklin Inst., **242**, 465 (1946).

(4) "Coefficients of Utilisation," Harrison, W., and Anderson, E. A. Trans. I.E.S. (U.S.A.), **15**, 97 (1920).

(5) "Lighting Design Calculations," Croft, R., *Electrical Times*, **130**, 39 and 82 (1956).



I.E.S. ACTIVITIES

Vice-Presidents and Regional Chairmen, 1956-1957

VICE-PRESIDENTS

R. G. Hopkinson

Dr. Hopkinson studied at Faraday House after which he joined the GEC Research Laboratories. In 1947 he went to the Building Research Station where he is in charge of lighting research. He has twice received the Leon Gaster Memorial Premium and has served on several IES committees. He has lectured in many countries on comfort in lighting.

J. S. McCulloch

Mr. McCulloch is a partner of R. W. Gregory and Partners. He received his technical education at Rutherford Technical College and in 1952 joined Merz and McLellan. In 1936 he joined his present firm and is engaged on the design of mechanical and electrical services for shipyards, factories and other buildings. He received the Leon Gaster Memorial Premium in 1953.

E. B. Sawyer

Mr. Sawyer received his technical training at the City and Guilds Engineering College and at the NPL. After a period with the Office of Works and with the BTH and Edison Swan companies he joined the Lighting Service Bureau and was appointed manager in 1946. He was Hon. Treasurer of the IES from 1953-56 and now holds a similar office for the NIC.

C. C. Smith

Mr. Smith received his early training with the Liverpool Corporation Electric Supply Department. He served in the REs during the war. He was appointed Deputy City Lighting Engineer of Liverpool in 1946 and City Lighting Engineer in 1948. He is a past chairman of the Liverpool Centre and a past president of the APLE.

W. T. Souter

Mr. Souter has served on various Society committees and on the Council on several occasions. He has given several papers in London and to Centres. He is a member of several NIC committees and represents the electrical industry on the Council of the APLE. He has been with Holophane, Ltd., for thirty-three years and is now joint managing director.

REGIONAL CHAIRMEN

Bath and Bristol

Mr. H. A. Turner is responsible for the Lighting Department of the Bristol Branch of the G.E.C. Ltd. Before and after the war he served in a similar capacity at the Swansea Branch. He was a founder member and first secretary of the Swansea Group, and was secretary of the Bath and Bristol Centre for three years. He is a Registered Lighting Engineer.

Birmingham

Mr. V. Heydon, A.M.I.E.E., joined the Illuminating Engineering Department of the G.E.C. Ltd. in 1936, being appointed Senior Lighting Engineer for the Birmingham area in 1948. He has served on the Centre Committee for a number of years and was Honorary Assistant Secretary for 1954/55. He is a Registered Lighting Engineer.

Cardiff

Mr. J. D. Callaway was formerly with Metropolitan-Vickers Electrical Co., Ltd., and subsequently with McLellan and Partners, for whom he was engaged on one of the major steel works projects in South Wales. He joined Philips Electrical Ltd in 1950 and is now their Lighting Division Supervisor at Cardiff. He was chairman of the Swansea Group in 1950/51.

Edinburgh

Mr. E. Cassidy served his apprenticeship with James Kilpatrick and Son, Ltd., and received technical training at Paisley Technical College. On completion of his apprenticeship he was appointed to the staff of the company and received further training in the estimating, invoicing and engineering departments. He is now manager of Kilpatrick's Edinburgh branch.

Gloucester and Cheltenham

Mr. Richard V. Parsons served an apprenticeship with his father's firm in Gloucester, after which he served six years with the Royal Air Force during the 1939/1945 war in the ground radar section. After the war he returned to the family electrical business, which was formed into a limited company in 1946. He is now a director of the company.

Leeds

Mr. W. L. J. Potts, B.Sc. (Hons.), A.R.I.C.S., A.M.I.Min.E., was educated at Gosforth Secondary School and King's College, Newcastle-on-Tyne. During the war he served in the R.A.F. After having been engaged on research in lighting in mines, he joined the staff of Leeds University Mining Department in 1949 as Lecturer in Mining.

Nottingham

Mr. G. F. G. King was born in Birmingham and educated at Solihull Grammar School. He received his early technical training with the G.E.C. Ltd., and during the war was attached to the Electrical and Mechanical Branch of the Royal Engineers in the North Midland District. Since 1948 he has been Area Manager of the Revo Electric Co., Ltd.

Leicester

Mr. C. P. Weston served an apprenticeship for five years in the electrical industry and has been for the last eight years Supervising Engineer at the Electrical Equipment Co. in Leicester. He is chiefly engaged in installation of lighting in schools and industrial premises. Mr. Weston has served a number of years on the Leicester Centre Committee.

Sheffield

Dr. F. A. Benson, B.Eng., Ph.D., a graduate of Liverpool University, was engaged during the war on radar research and development. From 1946 to 1949 he was an assistant lecturer at Liverpool University, where he gave courses on lighting to engineering and architectural students. He is now a lecturer at Sheffield University. His Ph.D. degree was for original work on waveguides and voltage stabilisation.

Liverpool

Mr. Fred J. Burns received his early training in the electrical contracting industry and joined Cryselco Ltd. as Sales Representative in 1941. He was appointed Liverpool Branch Manager in 1952. He has served as both Assistant Secretary and Secretary of the Liverpool Centre. He also served on the 1954 Summer Meeting Committee.

North Lancashire

Mr. H. Wilcock received his training with the Bolton Corporation Electricity Undertaking. In 1948 he was appointed to his present position of Power Sales Engineer with the No. 4 Sub-Area of the North-Western Electricity Board. He is a Registered Lighting Engineer and has been Hon. Secretary of the Group since it was formed in 1951.

Manchester

Mr. T. L. Robinson was Hon. Secretary of the Manchester Centre for four years. He is a Registered Lighting Engineer and specialises on lighting with No. 1 Sub-Area of the North-Western Electricity Board. He served his apprenticeship under the Municipal Electrical Engineer, Salford, and was with the Salford Electricity Department for 26 years.

Stoke-on-Trent

Mr. J. S. Beddows, A.M.I.E.E., received his technical training at the Birmingham College of Technology, after which he joined the G.E.C. Ltd. During the war he served in the Royal Engineers. Returning to the G.E.C. Ltd. in 1946, he was appointed Industrial Sales Representative in Stoke-on-Trent in 1947 and since 1953 has been Branch Manager.

Newcastle

Mr. P. S. J. Underwood served in the Mercantile Marine from 1918 to 1924 and was on the sales staff of Metro-Vick Supplies Ltd. from 1924 to 1929. In 1937 he joined Veritys Ltd., later being appointed their Industrial Fittings Representative in Newcastle. He was appointed District Manager in 1939, the position he still holds.

FORTHCOMING EVENTS

LONDON

October 9th

Sessional Meeting.—Presidential Address—"Lighting and Social History," by W. E. Harper. (At the Royal Institution, Albemarle Street, W.1.) 6 p.m.

CENTRES AND GROUPS

October 1st

LEEDS.—"Home Lighting," by Jean L. Stewart. (At the Yorkshire Electricity Board Lecture Theatre, Ferensway, Hull.) 7 p.m.

October 3rd

Edinburgh.—" Light Sources for Colour Matching," by E. E. Miles and D. C. Peach. (At the Y.M.C.A., 14, South St. Andrew Street, Edinburgh.) 6.15 p.m.

Newcastle-upon-Tyne.—Chairman's Address, by P. S. J. Underwood. (At the Large Lecture Theatre, Grey Hall, Department of Electrical Engineering, King's College, College Road, Newcastle-upon-Tyne 1.) 6.15 p.m.

Swansea.—Chairman's Address, by G. J. Higgs. (At the Demonstration Theatre of the South Wales Electricity Board, The Kingsway, Swansea.) 6.30 p.m.

October 4th

Cardiff.—Visit to Penylan Observatory, Cardiff.

Glasgow.—" Light Sources for Colour Matching," by E. E. Miles and D. C. Peach. (At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 6.30 p.m.

Nottingham.—Chairman's Induction followed by films. (At the Electricity Service Centre, Smithy Row, Nottingham.) 5.30 p.m. for 6 p.m.

October 8th

Sheffield.—Chairman's Address, by F. A. Benson. (At the Medical Library, The University, Western Bank, Sheffield 10.) 6.30 p.m.

October 9th

Liverpool.—Chairman's Address, by F. J. Burns. (At the Liverpool Engineering Society, 9, The Temple, Dale Street, Liverpool.) 6 p.m.

October 16th

Gloucester and Cheltenham.—" Recent Developments in Plastic Materials," by P. H. Collins. (At the Fleece Hotel, Westgate Street, Gloucester.) 6.30 p.m.

October 17th

North Lancashire.—Presidential Address, by Dr. W. E. Harper. (At the Demonstration Theatre, The North Western Electricity Board, 19, Friargate, Preston.) 7.15 p.m.

Tees-side.—" The Architect's Approach to Artificial Lighting Design," by G. Grenfell Baines. (At The Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.) 6.30 p.m.

October 18th

Manchester.—" School Lighting, Part 1," by G. S. Pester and J. Blackie. (At the Demonstration Theatre of the North Western Electricity Board, Town Hall, Manchester.) 6 p.m.

October 22nd

Leeds.—" Decorative Lighting and the Designers' Approach," by D. W. Durrant. (At the E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds 1.) 6.15 p.m.

Leicester.—" Aviation Lighting," by H. M. Ferguson. (At the Demonstration Theatre of the East Midlands Electricity Board, Charles Street, Leicester.) 6 p.m.

October 24th

Transvaal.—Annual General Meeting and Dinner. (At the New Club.) 6 p.m.

October 26th

Bath and Bristol.—" Light and the Eye," by Drummond Curry. (At the South Western Electricity Board, Bath.) 7 p.m.

Birmingham.—" Aerodrome Lighting," by J. W. Morse. (At "Regent House," St. Phillip's Place, Colmore Row, Birmingham.) 6 p.m.

October 29th

Leeds.—" Problems of Shop and Store Lighting," by K. C. White. (At the Yorkshire Electricity Board Lecture Theatre, Ferensway, Hull.) 7 p.m.

November 28th

Transvaal.—" Lighting of the New Johannesburg Railway Station," by H. N. Joubert and C. Parrymore. (At Room 95, Public Library, Johannesburg.) 8 p.m.

Situations

Vacant

Ekco-Ensign Electric Ltd. have vacancy in their London Office for Lighting Engineer. He should be well educated and conversant with modern lighting methods. Apply Senior Lighting Engineer, 45, Essex Street, W.C.2.

Lighting Engineer experienced in the design of street lighting fittings required by old established Manchester electrical company to set up street lighting department. Applicants, who must not be more than 35 years of age, should write stating full particulars to Box No. 925.

Illuminating Engineer required for preparation of interior lighting schemes in Westminster area, ability to discuss projects with architects essential. Salary up to £750 p.a. Write giving details of career to Box No. 926.

POSTSCRIPT By "Lumeritas"

THE RECENTLY published report of the Medical Research Council for the year 1954-1955 (Cmd. 9787, London, H.M.S.O., price 10s.) contains an interesting section on fallacies in the design of industrial work. One of these fallacies is that of an unchanging optimism in working conditions. "It is commonly assumed," says the report, "that the aim in investigations of industrial conditions is to search for the best temperature, or form of lighting, or method of work or the like, and, having found them, to maintain such standards without further change." Yet there is evidence, both from industry and from laboratory studies, "that slight and repeated changes in working conditions are often better than steady and uniform exposure to some supposed ideal or optional conditions."

It is high time that change should be clearly recognised as something essential to the achievement of wholly satisfying artificial lighting. Last year I commented twice (August and October) upon this much-neglected—indeed almost universally ignored—principle of good lighting; and at Harrogate this year it was refreshing to hear a paper by Strange and Hewitt (Light and Colour in Daily Life) which stressed the need for variety in artificial lighting—"variety in lighting levels, variety in brightness, variety in colour, and the lighting conditions that change with time, mood and occasion." Full marks must go to that prolific writer on lighting, Matthew Luckiesh, for having said all this almost 40 years ago (*vide* The Lighting Act, 1917, Ch. iv). His was a lone voice then and, unfortunately, he did not press his theme "variety—the spice of lighting" consistently in later writings, and with the same force of advocacy he devoted to other conditions of lighting.

Commenting on the M.R.C. exposure of the fallacy of static optima, a writer in the *Optician* remarks that working conditions should be designed "without forgetting the whole man, who is an animal designed for going to sleep when environmental conditions become constant." Any of my readers who recall Weston's paper on Visual Fatigue (Trans. I.E.S., Lond. **18**, 39-61, 1953) may remember that this effect of constancy in lighting was pointed out in the section on "visual boredom." To quote the concluding sentences of this section, "The achievement of 'ideal' static brightness ratios will not bring artificial lighting to life; what is needed—however impracticable it now may be outside the theatrical field—is some method of making lighting suitably variable though constantly adequate. Perhaps in no other way will continuous artificial lighting be made as universally endurable without complaint as daylighting is."

ANOTHER recently published report is that of the Road Research Board for the year 1955 (London, H.M.S.O., price 5s.). From the various investigations into the effect of street lighting on accident frequencies which have been made by members of the board's laboratory staff, estimates have been made of the relative casualty rates per unit of traffic under different conditions of lighting, the rate in daylight being taken as unity. Thus, the relative rate for fatal accidents to pedestrians in good artificial street lighting is estimated to be 3.6; in average lighting it is 5.6 and the rate rises to 6.4 in poor lighting and to 7.0 where there is no lighting. The corresponding figures for pedestrian casualties of all types are 2.0, 3.1, 4.0 and 5.1. As for the rates for fatal accidents to all classes of road user, instead of to pedestrians alone, they are 2.5, 3.4, 3.7 and 4.0. A less alarming state of affairs is revealed by the relative casualty rates for accidents of all kinds to road users of all categories; these rates are, respectively, 1.3, 1.6, 1.8 and 2.0. It seems clear from these sets of figures that poor lighting has little advantage over no lighting at all. As for good street lighting, apparently this brings the "all casualties" rate down to something reasonably approaching the daylight rate but, unfortunately, it does not have anything like such a good effect on the relative fatal casualty rates. It would be wrong, of course, to assume that if daytime-equivalent street lighting could be achieved by night there would be no difference between the day and night accident rates. There are diurnal changes in personal factors which almost certainly tend to increase the liability to sustain accidents during the later hours of the normal wakeful "day."

ONE OF THE principles of good lighting for interiors is that the brightness gradient should not be too steep in passing from one area to another, and from the interior to the exterior. This has often been emphasised with respect to factory lighting. It is also a valid principle in street lighting, but it is one which is often ignored. Thus, according to the *Yorkshire Post*, a new "accident alley" has appeared on the Great North Road near Doncaster, where a four-mile stretch of new sodium lighting ends abruptly—and on a bend of all places! The sudden transition from really good to little or no street lighting is sometimes disconcerting even on a straight stretch of road, but if the lighting "tailed-off" gradually the change-over to head-lighting could be effected calmly in good time instead of as an act of instant urgency that may, after all, be a split-second too late for avoiding an accident. In this connection it is interesting to note that the Road Research Laboratory is now observing the effect of a reduced lighting installation at the termination of a fully-lighted road.

YET ANOTHER recently published report is that of the I.E.S. Committee on Eyestrain in Cinemas. This has nothing to say about the lighting of cinema theatres and makes but the briefest mention of picture luminances. This is because the committee was specifically asked to consider the causes of "eyestrain" in persons occupying the rows of seats nearest to the screen and here, it appears, that the extent to which the viewer's gaze has to be elevated while watching the picture is a major factor affecting his ocular and general bodily comfort. The report confirms a recommendation for the maximum permissible angle of elevation of the picture made in 1920 by an earlier committee appointed by the Society, and it does so not merely on the strength of experiences of members of the committee, who viewed cinematograph displays at different angles of elevation, but also on the results of carefully planned experimental studies made by the Medical Research Council's Group for Research in Occupational Optics with a larger sample of viewers.

0, 3.1,
to all
e, they
affairs
ents of
es are,
r from
advan-
ghting,
down
at rate
e such
es. It
ytime-
t there
t acci-
factors
lity to
normal

nteriors
teep in
interior
d with
ciple in
Thus,
alley"
ncaster,
g ends
sudden
lighting
etch of
change-
od time
fter all,
nt. In
e Road
ct of a
a fully-

that of
This has
res and
es. This
onsider
he rows
that the
d while
s ocular
firms a
ngle of
er com-
merely
he com-
different
arefully
Medical
pational